THE FIELD ENGINEER.

M. le Chevalier DE CLAIRAC,

Tranſlated from the FRENCH,

WITH

OBSERVATIONS and REMARKS on each CHAPTER.

TOGETHE
With the Addition of ſeveral N w FIGURES, on a large Copper-Plate, to expla the AUTHOR'S CONSTRUCTIONS.

By JOHN MULLER,
Maſter of the Royal-Academy at WOOLWICH.

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TO

ROBERT NAPIER, Esq;

Lieutenant General, and Adjutant General, of his MAJESTY's Land Forces.

SIR,

YOUR favourable Opinion of this Author was my chief Motive to undertake the Work; and the constant Friendship you have honoured me with, during a long Series of Time, induced me to present it to your Patronage in an English Dress.

No one has a greater Aversion to flattery than myself, nor can I be suspected of it, when I say that few are better Judges, or more capable of distinguishing the Merit of this Work than yourself; as your amiable and disinterested Disposition has rendered you the Friend of all who have endeavoured to become

become uſeful to the Public, eſpecially in a Military Capacity, a grateful Acknowledgment is the leaſt Return that can be made, by thoſe who have had the Happineſs to be patronized by you, and particularly by,

SIR,

Your moſt Obliged,

and moſt Obedient

Humble Servant,

JOHN MULLER.

THE

EDITOR

TO THE

READER.

THE Author of this Work, being an Engineer of high Rank in the French Army, had great Opportunities to improve his Knowledge; during a long Courſe of Experience, he conſidered, that though many have wrote upon the Conſtruction of permanent Fortification, as well as upon the Attac and Defence of Places, yet little had been wrote in regard to the requiſite Knowledge of an Engineer in the Field, which he very juſtly thinks to be full as neceſſary as any other Part; for which Reaſon, he imagined a Work of this Kind would meet with general Approbation; as he has wrote upon very little but what he has ſeen and ordered to be executed, and having beſides,

the Qualification of a good Writer, it is no wonder that his Work has been ſo much eſteemed as to go through ſeveral Editions.

EVERY Officer may not be ſo well verſed in the French, as to be able to read the Original, nor perhaps ſufficiently acquainted with the Subject, it is hoped, that a Tranſlation, with proper Explanations, will prove acceptable. At the Beginning, where ſome Parts are expreſſed in a ſhort and abrupt Manner, the Words wanting to render the Author's meaning more conſpicuous, have been ſupplied; the ſame Liberty has been taken with the Author's Expreſſions, when neceſſary to render the Work more eaſy to Beginners. So that no ſtrict literal Tranſlation has been attempted.

I have added a new Plate, to explain thoſe of the Author's Conſtructions, which few Readers would have underſtood from his own Words. And Notes by Way of Obſervations at the End of every Chapter, to explain and enlarge upon what has been treated upon in that Chapter. All poſſible Care has been taken to explain every Subject, in ſuch a Manner, that any who have the leaſt Skill in drawing may underſtand every Part of it.

PREFACE.

PREFACE.

THE Knowledge neceſſary for an Engineer is of two different Kinds, one ſpeculative, demonſtrable, and conſequently invariable, ſerving as general Principles, and making Part of what is directly called Science; the other more practical and arbitrary, immediately comprehends the different Objects of his Profeſſion.

WE have a ſufficient Number of Treatiſes on elementary and practical Geometry, and on the Principles of Algebra; there are alſo good ones on Mechanics and Hydraulics.

IF thoſe Sciences, that is, thoſe Parts of the Mathematics neceſſary to be known previous to an Examination, were all that is neceſſary for the Theory, it is plain that all the Aſſiſtance requiſite is to be had; but to imagine it thus confined, is not to know the Extent it may, or ought to have.

INDEPENDENT of this ſpeculative, and preliminary Theory, there is a practical Part, which from Ideas, carefully examined, ſhews the moſt eligible Means of attaining the End propoſed, and procures us the ſecond Part of Knowledge neceſſary.

THOUGH theſe two Parts are equally neceſſary, we are as much at a Loſs for the Means of acquiring one, as we are abundantly provided for the other.

THE Reaſon of this Difference is evident: To treat of ſpeculative Knowledge, it is ſufficient to under-

ſtand Geometry, but much Experience is neceſſary to give ſatisfactory Inſtructions on the practical Part; and though the Number of Engineers, capable of doing this, were equal to that of other learned Men, their Employment, which confines them to the frontier Towns, and finds them almoſt conſtant Work, allows them little Time to range their Ideas in order, much leſs the Means of giving them to the Public.

YET the ſpeculative Theory, being only a Means by which we may arrive, by the ſhorteſt and ſureſt Road, to the practical, and of all Military Employments, ours being ſubject to the greateſt Variety, one may judge of what Importance that Aſſiſtance is, which we almoſt entirely want.

I ſay almoſt entirely, and a little Conſideration on the Knowledge of this Kind neceſſary for an Engineer, will convince every one, that the Expreſſion is not improper.

THIS Knowledge conſiſts in the Fortification, Conſtruction, or the Art of executing a Project with proper Solidity and Œconomy, the Attac and Defence of Places, and what regards Field Engineering.

I include Fortification, though I am not inſenſible it has its ſpeculative Theory, that is, Principles, or rather Maxims, which ſerve for Rules; the ſame may be ſaid of the Attac and Defence of Places, which are neceſſarily connected with thoſe Maxims. Beſides, thoſe Maxims are not capable of Demonſtration; and they are ſo dependant on the Situation, &c. of the Ground, and other phyſical Circumſtances, that not judging them fit to be ranked among Sciences purely ſpeculative, I thought I might place them in this Claſs.

ALL the different Parts of Engineering being relative to Fortification, which is without doubt the Principal; the different Parts of this Knowledge tending almoſt entirely to Fortification.

If the Number of Books could ſupply their Quality, we certainly could deſire no more upon this Subject? Moſt Authors have thought to reform the whole on new Ideas, by improperly changing the Inclination of one Line; others, to diſtinguiſh themſelves more, have imagined the moſt monſtrous Figures, induced thereto by the Eaſineſs of the Performance.

Writers of all Degrees and Profeſſions, even thoſe moſt incompatible with Arms, have preſcribed Methods and Rules, and this Jumble of uſeleſs Pieces have been honoured with the Name of Syſtem *.

I know that among the Number of Authors, there have been Engineers of eſtabliſhed and reſpectable Characters, ſuch as the *Chevalier de Ville*, *Count de Pagan*, and *Baron Coehorn*; I am far from confounding them with the others, but it is evident their Deſign in writing was leſs to inform Pupils, than to attain ſome Ideas, either new, or eſſentially differing but little from what was already known, and approved by Connoiſſeurs.

We cannot be ſurprized that in the vaſt Number of Books, there are not, perhaps, four worth reading on this Subject, and not one in which are found all the neceſſary Inſtructions which might be contained in a Treatiſe of a moderate Size.

Construction is an Art which includes ſuch different Objects, and depends on ſo many Circumſtances, that few Authors have treated of it, and none in a Manner ſufficiently inſtructive, or extenſive: We have nothing compleat in this Kind. An Engineer is often obliged, for his Inſtruction in ſo important

* The *Count de Montecuculi* was much of the ſame Way of Thinking; he ſays, in *Book* I. *Chapter* 5th, "But how many different Combinations may be made of the reciprocal "Proportions

portant an Affair, to his own Miſtakes, which are always attended with uſeleſs Expence.

We are much more fortunate in regard to the Attac of Places: The Mareſchal *de Vauban* who invented, rather than perfected this Art, has wrote on it as extenſively, as ſolidly: Since that valuable Manuſcript has been printed in *Holland*, there is nothing eſſential to be wiſhed for on that Head.

That great Man, in 1706, wrote a Treatiſe on the Defence of Places: Nothing indifferent can come from ſo maſterly a Hand, the Work is worthy the Reputation of the Author; but our Conqueſts, continuing almoſt without Interruption, not having given him an Opportunity of exerciſing his Talents on this Subject, as on the other, and it being an Object which conſiſts chiefly in Chicanery, or Stratagem, and therefore ſubject to much more Variety, it is thought that nothing can be retrenched from the Work, but much may be added to it.

Besides this Manuſcript (for I am not talking of what is publiſhed at the End of the Attac) is ſo ſcarce, that there is little Probability of its being ſoon printed.

Though moſt of thoſe, who have wrote on Fortification, have treated on that Part which concerns the Field, I may, without exageration, aſſert they have ſaid nothing to the Purpoſe.

What does it ſignify, in treating of ſuch a Subject, to give a Plan and Profil of Lines in ordinary Ground,

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" Proportions of thoſe Parts? How many Authors have
" treated of them? How different are their Diſcoveries?
" They are infinite and tireſome in thoſe Authors, who
" have been only Compilers, or copied one another, or
" have only chimerical Ideas without Practice. —— It is a
" *Proteus*, changing into a Thouſand different Forms."

Ground, to ſhew how to raiſe a Redout, or flank a Piece a little more extenſive, often contrary to the Rules of right Reaſon.

THIS kind of Forgetfulneſs has proceeded from different Cauſes; Gabinet Authors, to whom the Combination of a few Angles and Lines, gave room to diſplay their Skill in fortifying Places, not being able to treat of this Subject, founded almoſt entirely on Practice, by taking the moſt prudent Part, have abandoned it to its Profeſſors.

THE Conqueſts of a Reign, for a long Time happy, were not Circumſtances proper for perfecting an Art, whoſe principal Object is a defenſive War. It muſt alſo be obſerved, that a Brigade of Engineers was then thought ſufficient for an Army, this Brigade conſiſting only of ſix, and they generally employed.

THUS our Succeſſes were an Obſtacle to our Inſtruction; and it is not ſurpriſing, that in the ſmall Number of Men that afterwards had an Opportunity of improving themſelves, the Talent of arrangeing and expreſſing their Ideas, or an Inclination to publiſh them, have not been found united with the neceſſary Leiſure and Experience.

AFTER ſhewing in what we are deficient, I may be allowed to offer a Remedy.

THOUGH Fortification of Places, important as it is in itſelf, and in its Connection with the other Parts of this Knowledge, is, to ſpeak in general, that to which Engineers leaſt apply.

THIS Indifference probably proceeded from their having learned it by rote, without Principles, which a Maſter little ſkilled in the Art renders reſpectable by the Name of the Author, from whom he borrows it; and which makes them conſider it as confined, or already carried to its utmoſt Extent.

THAT a Science, ſo much neglected by thoſe whoſe Intereſt it is to cultivate it, ſhould have employed ſo many Pens, is a Conſideration inſufficient to remove this Prejudice, and I may venture to ſay, that the uninſtructive Uniformity, or diſguſting Whims of ſo many different Productions can only confirm it, and give a Diſtaſte to ſuch a Study.

IDEAS more extenſive, or more methodically ranged, learned at School, or immediately after, would give more Inſight, and a better Taſte for a Point ſo eſſential.

I could wiſh ſome Perſon of Capacity would begin, by explaining the different Parts which form the Front of a Fortification; for Example, to deſcribe a Rampart, Ditch, Covert-way, explain their Uſes, what ſhould be their Heighth and Breadth, the Advantages attending their being encreaſed, or diminiſhed; afterwards treat, with the ſame Attention, of the whole Incloſure, the different regular Figures, and the Outworks uſed to cover the Body of the Place; then ſhew how to draw a Plan after the principal Syſtems already known, examine them accurately, weigh their Advantages and Defects, and ſhew by the little Difference among thoſe Syſtems, the ſmall Progreſs yet made in this Art; then conclude by laying down general Maxims, and ſhewing how they ought to be applied to irregular Figures.

I am convinced ſuch a Work would produce very different Notions and Ideas of Fortification, from the preſent ones; and was it better known, it is probable would be more cultivated.

IF Practice be indiſpenſably neceſſary to form an Engineer, it is principally in regard to Conſtruction; and though I own this Neceſſity, it cannot be denied that in this Caſe, as well as others, ſome well wrote Treatiſes would remove the greateſt Difficulties. When perſonal Experience is neceſſary, but for want of

of Opportunity cannot be obtained, is it not a great Advantage to be enabled to benefit by that of others?

How useful would a Collection of Instructions be, chiefly drawn from Projects and Schemes, and enriched with Plans, Profils, and Designs of the different Kinds of Works, erected in *France*, since the Establishment of the Body of Engineers? I may assert that, not only young Engineers, but others would be greatly improved from such a Work.

SUPPOSE, for Example, any one is directed to build a Bridge over a Precipice, or to construct a Sluice, or a Reservoir on a considerable River, what better Models could be followed, than what has been lately done at *Briancon* and *Mentz*.

ALL the necessary Materials might be found in the Engineer's, or public Offices, and in the Hands of the Directors. The Engineer charged with this important Work should draw all the Plans, and arrange and unite the different Parts, which should be furnished by those appointed for this Undertaking.

MANY excellent Works now hid, or forgot, would be then exhibited, be of lasting and public Utility, and save the Crown vast Sums, daily lavished on defective, or ill constructed Buildings.

IT is evident, that I suppose the Interposition of the Government, but can there be any doubt of its Assistance to carry so useful a Project into Execution.

A Copy of Mareschal *Vauban*'s Memoirs, carefully compared with the original Manuscript, would be an excellent Basis for a compleat Treatise on the Attac of Places.

I would have joined to it, by Way of Commentary, all the Remarks and Additions that should be thought necessary. That Author's first Memoirs, some printed Books, the Writings of the best Engineers, and the most remarkable Passages, taken from the

the Journal of Sieges, would furnish ample Materials for such a Work.

THE same Method might be taken with that General's Memoirs on the Defence of Places, or, if thought necessary, it might be new modelled.

IN distinguishing, as I have done, the Attac and Defence of Places, from the Functions of a Field Engineer, it appears at first Sight, that the difference is so little as scarcely to be perceived, but Experience has convinced me of that Error, and I have imagined, that without quiting the Subject, Materials may be found for a Treatise, as full of Variety, as new, and instructive.

WHEN we consider, that of the five Parts of practical Theory, there is none, on which much more may not be said, there is no avoiding our surprize at a Neglect so prejudicial.

IT is certain, that what concerns the Construction cannot be clearly treated of, but by a well judged Collection of what the greatest Genius's have practised for several Years past, which requires the Assistance and Authority of the Government; but it might have been asked, and it is evident the same Excuse cannot be alledged for the other Parts.

IN vain do we seem to expect from other Hands that Assistance, which our Corps alone is capable of giving us: It must be an Engineer that can write well on this Subject, and I may venture to say, that being no less Men of Council than Military, it is not more honourable than advantageous to us, to leave to Strangers the Care of our Instruction.

THESE Considerations induce me to speak by Example; but proportioning my Task to my Leisure and Capacity, or, perhaps, enclined by the Novelty of the Subject, I at present confine myself to the ordinary Services of the Field, in which I have the Advantage of some Years recent Experience.

As

As Temporary, or Field Fortification, is the first and principal Part of this Service, its Theory shall be the Subject of this Volume.

If it be well received, I may be induced to proceed, it shall soon be followed by a Treatise on Construction; and to render it more compleat, I will add, as far as possible, all the necessary Instructions, on the most minute Works, and the different Commissions, that an Engineer may be charged with in the Field: It is well known that this Kind of Construction, quite different from that of permanent Fortification, is neither less extensive, or varied; and I may say, that I have little to seek for on this Subject.

The Instruction of our Body being my chief Motive, I shall gratefully receive any Hints that may be given for the Improvement of this Treatise, yet think it necessary to acquaint the Reader of a Point that requires his Indulgence.

Which is, the Necessity I am often under of speaking of myself; I know that such Quotations, particularly when they regard Sciences, are seldom excused, they are generally supposed to be the Overflowings of self Love, which wounds one's self, by arrogating a Kind of Superiority. The Case is therefore nice, but it should be considered, that there being scarcely any Thing wrote on this Subject, that could furnish me with Examples, I have been obliged to quote what I have seen, and put in Execution: That Field Fortification generally subsists but a short Time, and that Rank in which I served during the two last Wars, qualified me for such a Distinction, that I have seen little of this Kind, of which I had not the Charge.

I hope these Reasons will justify me, at least with the indulgent Reader; as to the others, they may if they please consider what I have wrote, only as a

Relation,

Relation, accompanied with Reaſonings, (and in a different Order from their Dates) of what I have ſeen or executed in this Kind: However this Error, if one, relative to the Author only, will not diminiſh the Utility of the Book.

I have little more to add: My Reaſon for putting a general Preface, before a particular Treatiſe; if I am ſuppoſed not to deſign writing ſucceſſively on the other Parts, it muſt be allowed, that it may be of Service in exciting other Engineers to it: Such a Motive juſtifies the reſt; and if it produces ſo good an Effect, may be more uſeful than this Work.

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The

FIELD ENGINEER.

CHAPTER THE FIRST.

I. *Of field fortification.* II. *Its particular maxims.* III. *Defects of saliant angles.* IV. *Means of correcting them.* V. *Redouts, their most perfect figure.* VI. *Their size and use.*

I. THE art of fortifying, constructing, attacking and defending fortified places, comprehends the most essential and most shining parts of a good engineer; but, as there are many other things to be known when in the field, his studies should not be confined to these objects alone.

An army, intrenched with judgment, produces, in many respects, the same effect as a fortress; for it covers a country, supplies the

want of numbers, ſtops a ſuperior enemy, or obliges him to engage at a diſadvantage.

On the other hand, being maſter of the field, there are poſts, heads of bridges, quarters to ſecure, and many other works to conſtruct.

The knowledge of a field-engineer being founded on the principles of fortification, it muſt be allowed, that the art of fortifying is as neceſſary to an army in the field, as in fortified places; but though the maxims are the ſame in both, yet the manner of applying and executing them with judgment, is very different.

A project of fortification is commonly the reſult of a long meditation; the engineer plans, digeſts, and examines it in his cloſet; he compares at leiſure his different ideas, and, provided the work be ſolid and durable, he is not anxious about time, materials, or any other neceſſary means, which he knows are to be had in the execution. But in the field it is otherwiſe, no regard is to be had to the ſolidity of the works; every thing muſt be determined on the ſpot; the works are to be traced out directly, and regulated by the time, and number of workmen, depending on no other materials than what are at hand, or on other tools than the ſpade, ſhovel, pic-ax, and hatchet.

It is therefore in the field, more than any where elſe, that an engineer ſhould readily know how to ſeize on all advantages at firſt ſight,

ſight, to be fertile in expedients, inexhauſtible in inventions, and indefatigably active. Vivacity and fertility of genius, which are natural talents, are not ſufficient, without the knowledge acquired by practice. To contribute to this knowledge as much as poſſible is the deſign of this work.

II. To begin, I ſhall add to thoſe general maxims of fortification, which the reader is ſuppoſed to be acquainted with, ſome partilar ones, by way of general rules.

Firſt, to incloſe within the work as much ground as poſſible, having regard to circumſtances. This attention, which principally concerns redouts and ſmall forts, is neceſſary for the guards of theſe works, to lodge themſelves, and to move commodiouſly; on the other hand, that the troops may be leſs crowded in their camp, or different motions.

Secondly, if there are ſeveral works near each other, that their lines of defence are ſo directed, that they may defend each other, without annoying themſelves by their own fire. The utility of the one, and the inconveniency of the other of theſe obſervations, are too evident to need an explanation.

Thirdly, not to depend on the defence of ſmall arms, but where the ſoldiers can fire at right angles; becauſe they generally fire without aim, and directly before them.

Fourthly, not to have recourſe to the ſecond flank, or fire of the curtain, but when there is an abſolute neceſſity. This maxim

is a consequence of the former; it will appear besides, in article III. of the next chapter; that the real defence is not to be estimated by the length of the oblique flank, but by that of the perpendicular, let fall from its extremity on the line of defence.

Fifthly, that the flanking angle, that is the angle which the flank forms with the line of defence, be always a right one, or more obtuse, but never to exceed 100 degrees, if possible; because there is no fear here, as in a fortress, that the flank be too much exposed. Besides, it is not necessary to graze the faces, or even to fire obliquely on them; since there is no danger of being exposed to the defence of a breach, or lodgement of the miners. The only thing to apprehend, is a sudden attac, commonly in column, by a superior enemy, difficult to resist, if once got over the ditch; it is therefore necessary to stop him at some distance, to discourage him, and not to increase our own danger, by exposing us without necessity to our own fire; which unavoidably happens, if the flanking angle be acute; because in these moments of confusion, the fire is always badly directed; yet, at the same time, the opposite extreme ought to be avoided, not to make the angle too obtuse; for in this case, the fire does not so well defend the ditch; it spreads too much, and does not cross, or very little, before the saliant angle; for these reasons, rather than the desire to lengthen

the flank, I prefer, when convenient, the angle of 100 degrees, to a right one.

Sixthly, that the flanking parts be sufficiently extended, so that the interior of their parapets at least rake the whole breadth of the opposite ditch. When the enemy is near, especially in column, a front fire seldom stops them; as the enemy is under cover, when in the ditch, from all other fire but that of the opposite flank, which therefore should be as long as possible.

Seventhly, never to make an advanced ditch in dry ground, unless it may be enfiladed throughout, and under a proper angle, to be defended by the work which it covers or surrounds.

Works, without flanks, such as redouts, and those whose flanks are too oblique, or not sufficiently extended, are the only ones which should not have advanced ditches *.

Eighthly, not to allow more than from 60 to 80 fathoms for the lines of defence, when they proceed from two flanks separated by two branches, which form a saliant angle, or when not made to cross though produced.

As the flanked angle of polygons, designed by the first case, are the parts most exposed, they cannot be too well supported; the second particularly concerns † indented works,

 where

* We have omitted a great part of this paragraph, as being of no use to explain the rest.

† *Cremailleres*, is rendered in English *indented*, as meaning

where the defences being parallel, and directed the ſame way, cannot croſs each other, the fire of one flank ought to be doubled by that which precedes it; as may be ſeen in the article of lines.

Ninthly, that the parts moſt extended, and conſequently the weakeſt in themſelves, be as much defended as poſſible, and have at leaſt the fire of two flanks, beſides their own direct fire. Nothing can be plainer, than to defend that moſt, which wants it moſt.

III. All fortifications, ſuppoſe either a plane figure or a line only, that are or may be put into a ſtate of defence. A line is not eſteemed fortified, but as it is flanked; fortification therefore neceſſarily ſuppoſes angles, and conſequently ſaliant ones.

If the ſaliant angles are formed by right lines, they have the advantage above others, of being defended and grazed in all parts: this muſt be clear to every one, yet in my opinion, their defects have not been minutely conſidered. The ſoldier generally fires mechanically, and conſequently right before him; experience has ſo often convinced us of this, that it may be laid down as an axiom. It follows then, that at the point of each ſaliant angle, there is a conſiderable ſpace which is not raked by any direct fire; for I look on

one

ing the ſame thing, viz. like the teeth of a ſaw, as may be ſeen in plate I. figure 4. where the covert way is indented.

one man that may be placed there, as nothing. That ſpace is a circular ſector, terminated by the ſides of the angle produced, and the radius the utmoſt range of a muſket ſhot; ſo that, if this angle be a right one, and the muſket range 150 fathoms, there will be a ſpace of about 17679 ſquare fathoms, where the beſieger has no fire in front to fear. It is from this knowledge, often very ſuperficial, that trenches are conducted, as much as poſſible, on the prolongation of the capital, and that ſkilful officers direct their march, as well for the attac of the covert way, as for that of any other work. Plate I. Fig. 1.

IV. To remedy this defect, ſome engineers round theſe angles, which, in effect, diſperſes the fire equally every where: this method is preferable to the common conſtruction; but the rounding being of little extent, for fear of leſſening the place of arms, or the work, the fire becomes very ſmall and ſcattering. Fig. 2.

As it is the capital, which is the moſt diſtant from the flanking parts, and has likewiſe moſt occaſion to be defended, I would rather chuſe to cut this angle off by a right line. Both theſe methods diminiſh the defect only; the following one remedies it effectually, and is eaſy in practice, at leaſt in fortified places. Fig. 3.

Trace the interior part of the parapet, not in a right line, but indented, obſerving that one face of each redan be perpendicular, and the other parallel to the capital; a conſtruction that ſeems the moſt advantageous, as Fig. 4.

two or three different defences are drawn from the ſame part.

It is not at all ſurprizing, that men of genius often hit upon the ſame thing, M. *de la Fon*, director of fortification of the maritime places in *Flanders*, ſhewed me, in 1740 at *Dunkirk*, a project of this kind, in tracing a covert way: M. *de Verville*, formerly chief engineer at *Rocroi*, to whom I had not mentioned it, ſhewed me the plane of a ſquare redout, in 1741, then at the army upon the lower *Rhine*, wherein he had propoſed to defend the angles in this manner. So uſeful a diſcovery cannot but do theſe gentlemen honour, and I hope they will not be diſpleaſed at my mentioning their names.

V. A redout is the ſmalleſt piece of fortification that is conſtructed; I comprehend under this name, every field-work, not flanked by itſelf; they are of two ſorts, one with a parapet, the other a * *Machicoulis*: this laſt is ſeldom uſed in the field, yet I have ſeen one in 1734, at a line of *Etelingen*; it was an exagon of timber-work, which ſerved for an intrenchment, and guard-houſe to a more conſiderable work. Redouts with parapets are more frequently uſed; they ſerve in the defence,

* *Machicoulis*, is an old word, ſtill applied to projections in old caſtles, and over gates of towns, left open above, to throw down ſtones, &c. but it is not eaſy to underſtand the author's meaning in applying this word to forts; nor do I think it very material to underſtand it, in the ſequel of this work.

defence, and sometimes in the attac of places, and frequently in that kind of war, we are here treating of.

When there is no particular reason to the contrary, their form is commonly square, observing to oppose one or more sides to the places to be commanded. If the redout is within reach of some other works, such as a covert way, or lines, its faces must be turned so, as to be defended by these works. It is essential in this case, to join all together by a communication; besides the assistance and a secure retreat, obtained by this disposition, it has the advantage of not being attacked in the rear, but with great difficulty.

A communication, well made, may besides give right and left flanks to those parts by which the work is protected, as may be seen in chapter VII. It has been observed, what service it is to remedy the defects of saliant angles in general, in regard to redouts, it is not only useful, but necessary.

From what has been said on this subject, we may conclude, that the surface which the piece rakes, or fires on, is to that which it does not, as the interior of the polygon, multiplied by the range of musket shot is, to the superficies of a circle, whose radius is the length of the shot; so that, supposing this range of shot always to be 150 fathoms, there is about a redout of 40 fathoms interior parapet, a space of 6000 square fathoms exposed

poſed to its fire, and a little more than 70714 that are not.

As this rule is general, and the number of ſides makes no difference, it may be thought that a circle has not more advantages than another figure; becauſe it is only a polygon of an infinite number of ſides: this demands ſome examination.

Although the ſpace a ball paſſes through has no greater breadth than its diameter, yet as each man that fires takes up two feet in front, I ſhall ſuppoſe it ſufficient to fire on a breadth of two feet.

If the redout has forty fathoms interior circumference, its fire will form 120 parallellograms, which touching each other by the extremities of the ſmall ſides, leaving between the great ones 120 ſectors, which together form, as in the ſquare, a circle of 150 fathoms radius.

Conſequently, a circle may not only be conſidered as a polygon of an infinite number of ſides, but as one of 120 only.

I agree to theſe facts, which prove the rule I laid down extends to circular figures; but I am likewiſe convinced, that this figure, is much preferable to the rectilineal one.

In the ſquare, for example, there are only four ſpaces which are not defended; but each of them contain right angles, and conſequently, near 17679 ſquare fathoms; whereas, by this ſuppoſition, I have in fact 120 ſpaces not defended, but each is leſs than 590 fathoms

thoms-ſuperficies, and drawn from an angle of three degrees only *.

However great this advantage may be, there is one much more conſiderable; it is, that all the points of the circumference of a circle, being equally diſpoſed, the ſoldier poſts himſelf indifferently throughout; which makes the ſpaces defended vary every moment, and the enemy is ſecured in no particular part.

We may then certainly conclude, that the round redout, though little or not at all uſed, is the moſt perfect we can form; that the fewer ſides theſe works have, the more defective they are; and that the contents of the ſpaces not commanded being the ſame in all caſes imaginable, the larger they are, the leſs this diſadvantage is in proportion.

The circular figures, though preferable, cannot be uſed but on certain occaſions; if, for example, it be required to fire on an object of ſmall extent, without doubt a front muſt be oppoſed, whoſe fires will be parallel to each other; other circumſtances require a mixt figure, but in all theſe caſes, regard muſt be had to the defects of the angles.

The

* As 120 ſpaces, of 590 ſquare fathoms, make 70800 fathoms, which is above four times the ſpace 17679; and therefore the circular figure is leſs advantageous in that reſpect, than the ſquare one; it is true, theſe ſpaces are more equally divided all round, than in the ſquare, whereby one defect is in a manner recompenſed by another advantage.

Plate II. The moſt infallible method is, certainly that which we quoted at the end of the preceding article: the defect not only diſappears by that ingenious means, but that part becomes yet ſtronger than the ſide itſelf, as the extent of its defence is equal to that of the diagonal; yet as the face of the redan ought not to be much more than three feet, it appears difficult to execute it without ſome ſort of revetement, which we have ſeldom time, or means to make in the field.

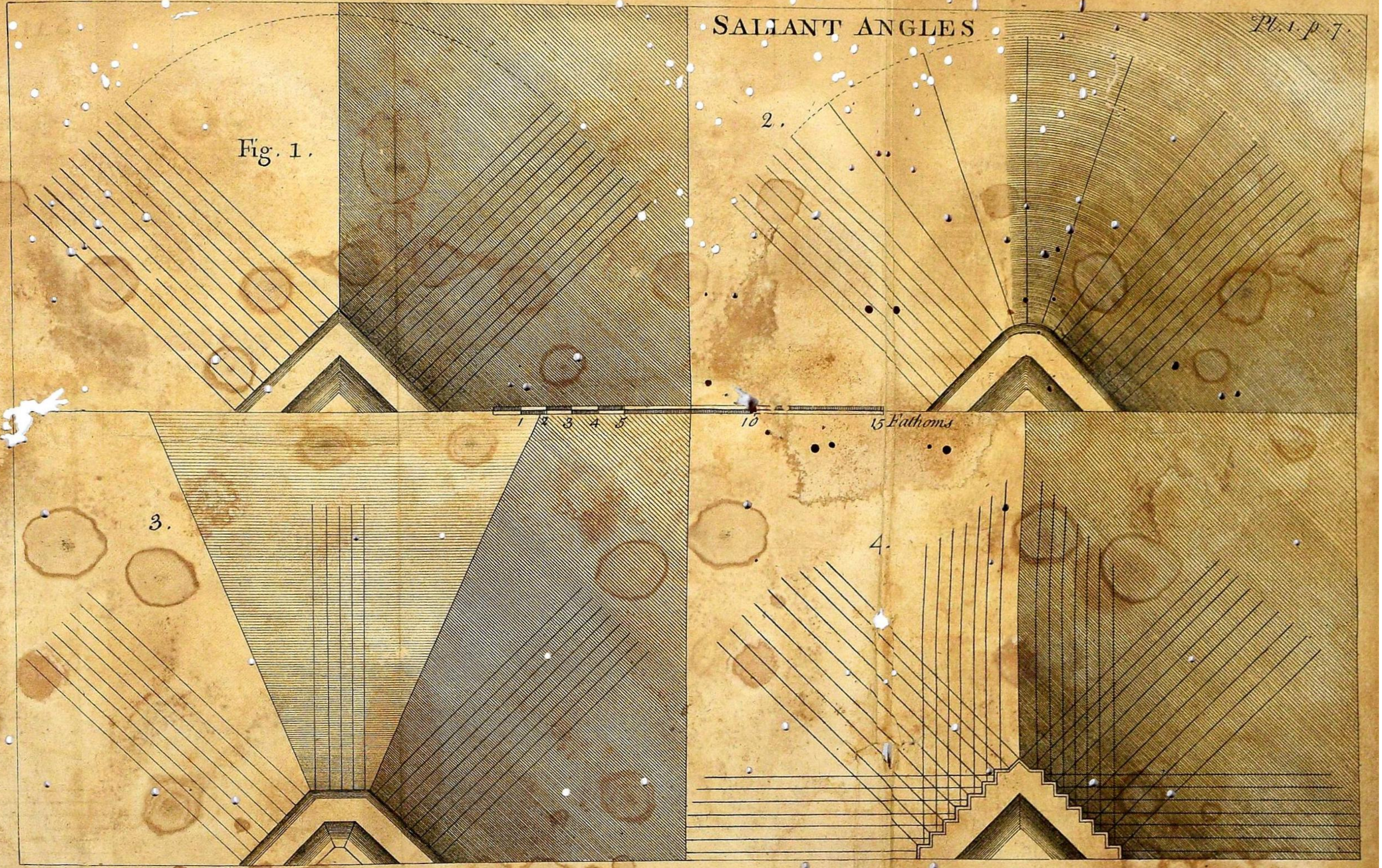
We then ſhall often find it neceſſary either to cut off the angle, or round it; if the latter, the rounding ſhould be as large as poſſible; and it muſt be farther obſerved, that the flatter it is, the more it will throw the fire towards the capital.

VI. The ſize of the redout is ſometimes determined by the nature of the ground, but more generally by the number of men deſtined for its defence.

A parapet is well lined with two men to every fathom; this knowledge is neceſſary, but not ſufficient to determine the ſubject of this article.

Forty men, for example, cannot, becauſe of the banquet, be contained in the *Terreplein* of a ſquare redout of five fathoms interior parapet for each face, and 160 will be too many for that of twenty fathoms in each ſide; becauſe in ſimilar figures, that, whoſe ſide is four times leſs than another, has 16 times leſs contents.

Hence


SALIANT ANGLES
Pl. 1 p. 7.
Fig. 1.
2.
3.
4.
1 2 3 4 5 10 15 Fathoms

Hence regard must be had to the extent of the circumference, and to the surface at the same time.

A redout of twenty four fathoms parapet, that is, if it is a square of six fathoms interior parapet in each side, is the least that should be used.

On the contrary, they should not exceed 64 fathoms, that is, 16 in each side; for as these pieces have no flanks, it is better, when we would have a work of a considerable extent, to throw up little forts, which I shall treat of hereafter. A remark, which probably escaped the notice of the engineer, charged with the construction of the lines of *Etilingen*; for towards the extremity of the left, where we forced them, I saw a redout of about forty fathoms each side: in this gigantic piece was, that *Machicoulis* of timber, which I have already mentioned.

A redout of 24 fathom interior parapet will contain 36 men, and they are sufficient for its defence: that of 64 fathoms will not be crowded, and will be lined two deep with 256 men. But the numbers of 36 and 256 are the square of 6 and 16, that is, the fourth part of the extent of these pieces; we may then conclude, that if we quadruple the square root of the number of men, which may be destined for such works, it will give the extent of the circumference in fathoms.

If, on the contrary, the number of men a redout can contain be required, square the fourth

fourth part of the fathoms of its extent or circumference, and the product is the number.

For example, what dimensions should be given for 100 men? Multiply 10, the square root of a 100, by 4, it will give 40 fathoms for the extent of the parapets of all sides: on the contrary, multiply 10, the fourth of the extent, by itself, the product of 100 is the number.

Large redouts, by this rule, contain in proportion, more than the small ones; but this must be an advantage; since they are not constructed, but in places of importance, or those most exposed, and if it should be thought proper, the number may be diminished. This method is sufficient in practice for figures from 24 to 64 fathoms parapet; but it must be remembered, that the extent being equal, that which has most sides can contain the most.

The use of redouts in the field, is commonly to secure a post, a grand guard, or communication; to defend a defile, a bridge, or a ford; they may be useful also in flanking lines, as we shall see hereafter.

In some cases they may be necessary, to keep the enemy at a distance from some considerable post. In 1734, after the taking of *Philipsbourg*, we scarcely dared to graze our horses 100 fathoms from the pallisades; the hussars carried off, and killed an officer at the very foot of the *Glacis*, and the Imperialists, masters of that side of the *Rhine*, marched in

in broad day, and paſſed their baggage over the capucin-hill within cannon-ſhot of the place.

When I had repaired two old redouts on the ſide of the hill, and conſtructed a third; the huſſars appeared no more, we kept our paſture, and they marched off through the wood.

Observations on the firſt Chapter.

The author, conſidering that engineers ſtudy chiefly the manner of building, attacking, and defending fortified places, and that the knowledge required in the field during a campaign, for the uſe and ſecurity of an army, has hitherto been much neglected, although not ſo ſhining, yet as uſeful as the attac and defence; for which reaſon he has publiſhed this work, as the reſult of a long experience and theory, built upon the moſt unexceptionable principles.

He begins with adding ſeveral maxims or general precepts, to thoſe commonly laid down by writers upon fortification; and endeavours to correct ſome defects ariſing from the uſual conſtruction of the ſeveral parts of a fortification; one of the moſt conſiderable is, that all ſaliant angles have no direct defence, whereby the approaches are always made in the direction of their capitals, as being the leaſt dangerous; to prevent which, and render that part as ſtrong as any other, he makes the faces AB, CB not in ſtrait lines Plate A Fig. 1.

as

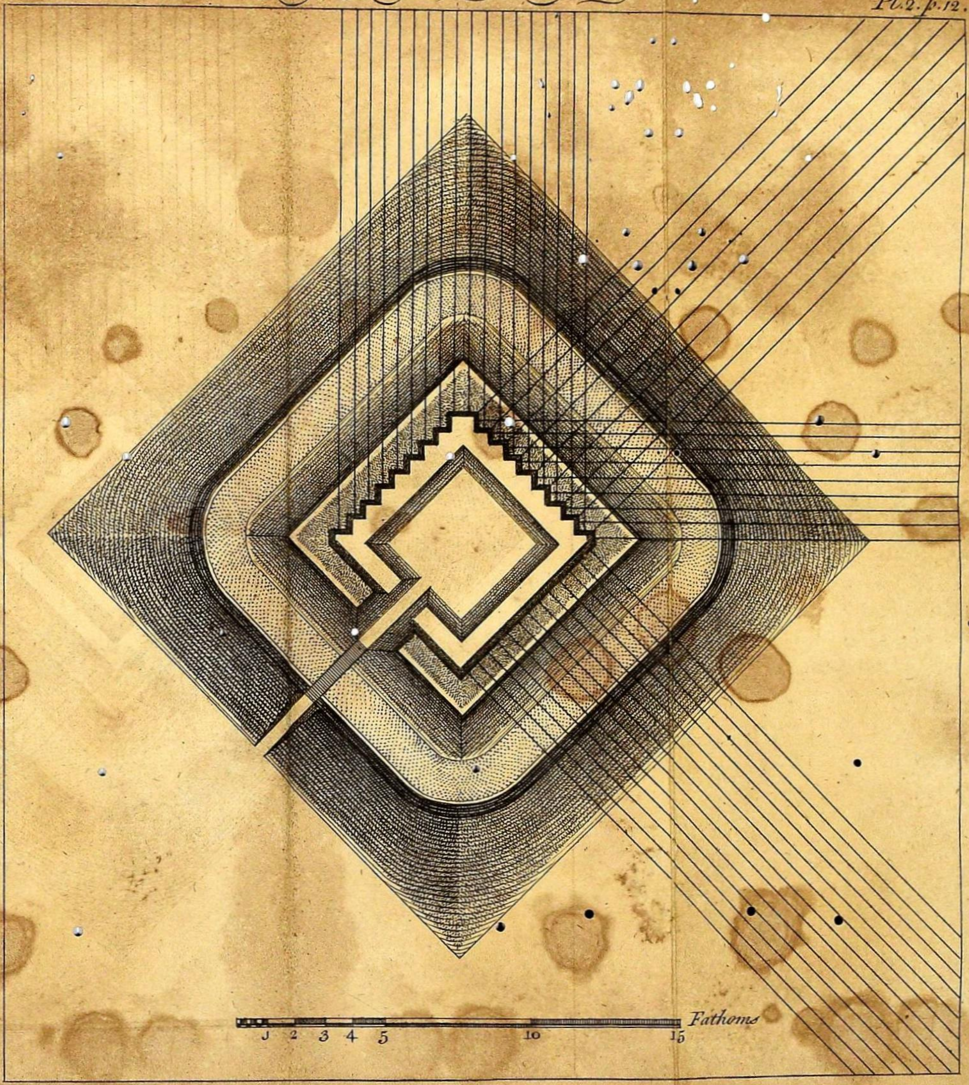
as is the custom, but indented as is the face AB, in the following manner; draw AC and BD perpendicular to it; divide AB into any number of equal parts, and through these points of division draw lines parallel to AD and DB: these lines meeting each other at right angles, will form as many flanks to defend the angle B as are equal to AD; and therefore the angle B will be defended by a flank equal to AC, in the direction of the capital DB, and each face AB will be defended in the direction DA, by a flank equal to the perpendicular BD.

The author observes, that the parts parallel to AD, should generally have not above three feet, as being sufficient to place one man; it would be a difficult matter to support the earth on the inside without a brick wall, which is seldom to be done in the field; but as sods will answer the purpose full as well as bricks, in works of a short duration, this objection is of no consequence.

As each face parallel to AD is to its flank as AD is to DB; their proportion seems to be limited when the angle B is given, which in some cases may not be convenient; this may be obviated by drawing a line BE; and making the flanks on the side BC, parallel to that line; then they will be to their faces as BE is to DE; and the total defence of the angle B will be to the defence of BC, in a direction perpendicular to BE as twice DE is to BE.

If

INDENTED REDOUT



If the parapet of the covert way was thus indented, and the facet 8, 10, or 12 feet, and the flanks twice that length, without any traverses, the defence would, in my opinion, be better than when they are made in the usual manner; and then the covert way need be no more than five fathoms broad. For, when there are no traverses, the enemy would find no shelter when he has taken it, the troops placed in the redans could not be disturbed by the ricochet firing, and the motions would be more convenient. Besides, a piece of cannon might be placed in each redan, and thereby render the approach more dangerous. I know, that it is not customary to place cannon in the covert way; but, as it is the first work attacked, cannon placed there can defend it much better than from the bastions, by a grazing fire, and keep off the enemy at a greater distance, till such time that the covert way is in danger of being taken; they may then be removed to the inner works: besides, the present practice of the most experienced engineers is, to make the capital works as low as possible, to prevent them from being seen from the same batteries as the outworks; cannons in the covert way are in this case absolutely necessary.

Some engineers turn the saliant angles into a circular arch, in order to get some direct fire, but as only one gun can be placed there, this practice remedies the defect but little; the author thinks it would be better to ter-

minate it by a right line; but even this is not ſufficient without forming the parapet as deſcribed above.

In all ſquare or triangular redouts, without baſtions, the ſaliant angles cannot be defended from any part whatſoever, when their ſides are right lines, and therefore are very defective, unleſs one of the fronts ſerves to defend ſome particular paſs, and the ditch can be filled with water; for which reaſon, our author recommends the circular form, as preferable, though not hitherto uſed; becauſe every part is equally defended. In either caſe, the ſlope of the parapet ought to be as great as conveniently can be done, without weakening it too much, the overplus of the earth, taken out of the ditch, ſhould be laid on the outſide in a glacis, to make the fire from the parapet more grazing; and wh[illegible] the ditch is dry, a row of paliſades muſt be placed in the middle, and the parapet fraized.

The bigneſs of a redout is commonly determined by the figure of the ground, and by the number of men to defend it. It is ſuppoſed, that every man takes up three feet of ground; upon this ſuppoſition, it is eaſy to find the number of men to defend a work, placed two or three deep, from the length of the parapet at the inſide. But our author obſerves, that this ſuppoſition is not juſt; becauſe greater ſquares contain more room than ſmall ones, in proportion to the ſquares

of

of their ſides; and therefore the number of men ſhould be in the ſame proportion.

The author ſuppoſes, that 36 men are ſufficient to defend a ſquare redout, whoſe interior ſide of the parapet is 6 fathoms; from whence follow theſe general rules. I. To find the number of men to defend a ſquare redout without baſtions; ſquare the ſide expreſſed in fathoms, which gives the number of men required. Thus, if the inſide is 12 fathoms, whoſe ſquare 144 is the number of men required. II. The number of men to defend a redout being given, to find the ſide; extract the ſquare root of the number of men, and you will have the interior ſide expreſſed in fathoms. Thus, if the number of men is 100, then the ſquare root 10 will be the number of fathoms required.

If the number of men is not a perfect ſquare, take the neareſt root under that number. Theſe rules are ſufficiently exact in moſt caſes; but as circumſtances may vary, regard muſt be had to the importance of the poſt, and to the number of men an enemy may bring againſt it. It is not always ſufficient, to line the parapet two or three men deep, but there muſt likewiſe be a reſerve at hand, to replace thoſe that are killed or wounded. It is therefore the duty of the commander, to regulate the number of men according as he judges it neceſſary.

CHAPTER THE SECOND.

I. *Field forts in general.* II. *Star forts.* III. *Second flanks.* IV. *Triangular and square forts.* V. *Heads of bridges.* VI. *Their figures according to different cases.* VII. *Those of a more durable construction.* VIII. *Scheme of moving flanks.* IX. *Other uses of armed boats.*

I. SMALL, or field forts, have the advantage of redouts, in being flanked, and the disadvantage in containing less within, in proportion to their extent.

We may consider them of two kinds: the one, defending itself on all sides, is entirely surrounded, and is what properly falls under this name; the others, bordering on a river, precipice, &c. remain open at the gorge.

Some cabinet authors, for want of experience, have given pitiful designs on this subject, and sometimes engineers fall into gross mistakes, in the tracing them, for want of a proper attention.

These forts, as all the rest, are regulated by the general maxims and principles I have given; observing in consequence of those maxims, never to construct a fort, under a certain size: it is better in that case to erect a redout, to preserve more capacity.

The size, and construction of these works differ, according to the manner in which they are to be fortified.

II. The

II. The moſt ſimple is, to * brake the lines in rentrant angles, which gives oblique flanks, without ſhoulders.

By the general maxims I have eſtabliſhed, we ſhall find, that the obliquity of theſe flanks, though often great, is only more or leſs defective as it exceeds the angle of 100 degrees; and no regard ſhould be had to the dead, or rentrant angles which they form.

Theſe are called ſtar redouts, becauſe they reſemble that figure; *Adam Fritach*, who, on this ſubject, quotes the ſiege of *Breda*, ſays, they are commonly made of four angles, ſometimes of five, and very rarely of ſix.

He conſtructs them by giving in the ſquare one eighth, and in the pentagon one ſixth of the length of the ſide, to the perpendicular which forms the brake. Plate III. Fig. 1, 2.

The flanking angle in one, is thus 152 degrees nearly, and more than 143 in the other: as they cannot be cloſed much more, no great protection muſt be expected from theſe flanks; yet the fire, croſſing at a ſmall diſtance, the polygon is without doubt better defended, than by a right line; but the ſaliant angles, eſpecially in the ſquare, are too much expoſed.

I do not mention the difficulty of tracing a pentagon in the field, without inſtruments, becauſe

* To brake a line, is to make it with one or more angles, either ſaliant or rentrant; the line ſerving for the baſe. See the notes at the end of this chapter, where all the conſtructions given throughout this chapter are fully explained.

becauſe every engineer ought to have always a needle by him, which is ſufficient for that purpoſe.

Plate III. Fig. 3. *Fritach* ſays nothing of the conſtruction of ſtars of ſix angles: *Father Dechales* forms them of equilateral triangles; this figure is regular, and I believe the moſt perfect of its kind.

The flanking angle being thus 120 degrees, the fires croſs better and nearer, and as the two flanks are on the ſame line, the ſpace, not defended before the ſaliant angle, is reduced to a parallelogram, whoſe ſmalleſt ſide is equal to the gorge.

Plate IV. Fig. 4. We may rank with theſe, ſtars of eight points, which this eccleſiaſtic calls a ſquare; it is in effect a ſquare, where one third part of the ſide ſerves as a baſe to an equilateral triangle, which flanks the reſt.

This figure, though irregular, has the advantage of the preceding one, in containing more ſpace, and croſſing its fires on the four right angles: as to the redans, the breadth of the ſpace not defended, is as in the other, perpendicular and equal to the gorge.

If we compare theſe different figures, we ſhall find, that the defence increaſes, as well in front, as on the ſaliant angles, in proportion to the number of ſides; therefore, contrary to the opinion of the *Dutch* author, the ſtar of ſix points is preferable to that which has leſs, and that of eight points is preferable to that of ſix.

Their

STAR FORTS
Pl. 3 p. 21.
1
2
3.
Fathoms
5 10 15 20 25 30

Their moſt perfect conſtruction is, to form on each ſide of an octagon, an equilateral triangle. The figure is regular, its flanked angles are 60 degrees, and its flanking 105, which is not too much; but, as it is not very eaſy to trace this on the ground, the following comes very near it.

Biſcet the ſides of a ſquare, giving one eighth of the ſide to the perpendicular, as in the ſtar of four points, and elevate on each front an equilateral triangle, the third of one of the eight ſides ſerving as a demi-gorge.

The flanked angles, by this, become alternatively 61 degrees 56 minutes, and 60 degrees; and the flanking angles 105 degrees 58 minutes. I executed this work in 1743 on the queich, and it was approved.

I think they ſhould be limited to this number of points; it is very difficult to trace them, and beſides, uſeleſs to the defence, if they have any more.

III. The conſtruction of baſtioned forts, differs in nothing from that of places, except that the figure being ſmaller, and the attac ſuppoſed of another kind, it is reckoned ſufficient to flank them with half baſtions.

The face of half baſtions draw their only defence from what we call the ſecond flank, that is, from one part of the curtain; on which we muſt make an eſſential obſervation.

I have ſhewn, that the ſoldier generally fires directly before him; though this is an important point, I will take no notice of it

here, but ſuppoſe on the contrary, that he fires in the proper direction.

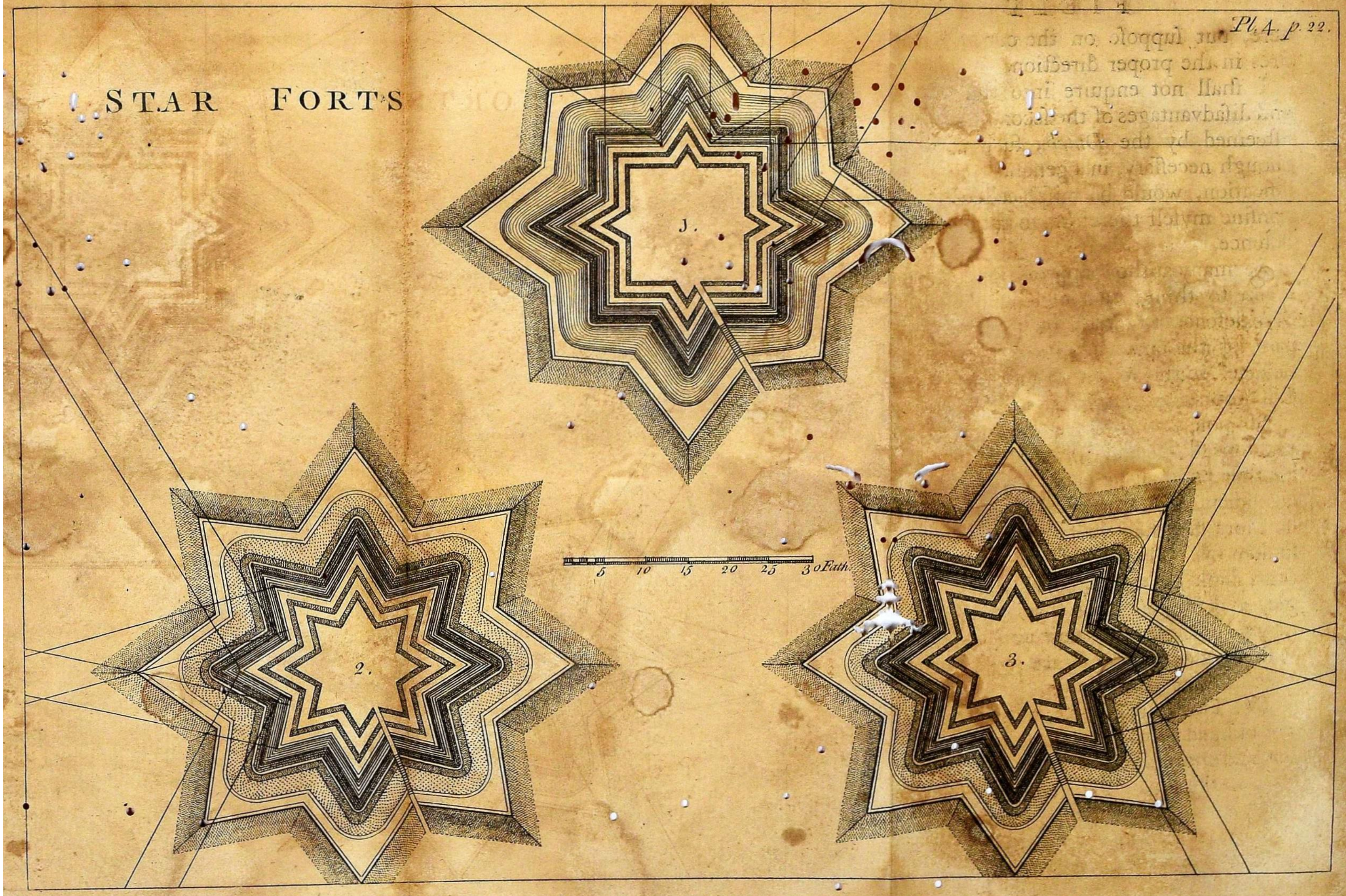
I ſhall not enquire into the advantages and diſadvantages of the ſecond flank, ſo much eſteemed by the *Dutch*; ſuch a diſcuſſion, though neceſſary, in a general treatiſe on fortification, would be miſplaced here; I ſhall confine myſelf therefore, to the effect of this defence.

Plate V. Fig. 1. So many authors approving of them, give room to think, that ſome of them ſuppoſe this defence to conſiſt in the length of this part of the curtain, inſtead of which, it is reduced to the length of a perpendicular, let fall from its extremity on the line of defence.

Suppoſe two or three feet interval between each muſket, the diſtance of a parallel to another being to be taken perpendicularly, it is evident, that the ſecond flank will give no more fire than that perpendicular we have ſpoken of. That is, if the length of the ſecond flank be 54 feet, and the flanking angle, as I ſuppoſe it in a triangular fort, 166 degrees 6 minutes, there will not be 13 feet real defence. The figure will explain this much better than words.

IV. This ſecond flank, which, after all, we are obliged to have recourſe to here, is ſmaller, and more oblique in the triangular figure than in the ſquare; the triangular figure contains leſs in proportion, which is a diſadvantage according to our maxims; for this reaſon, we avoid uſing them, if poſſible; yet

as


STAR FORTS
Pl. 4. p. 22.
1.
2.
3.
5 10 15 20 25 30 Fath.

as circumſtances ſometimes oblige us to it, the following is the beſt method of fortifying them.

Form an equilateral triangle, and divide the ſide into three equal parts; lay one of these on the prolongation of the ſide for the capital; draw the line of defence from this point to the extremity of the other ſide of the triangle; make the gorge equal to the capital, that is, to one third of the ſide; raiſe the flank perpendicular according to *Fritach*, or rather about 10 degrees more open, as in the plan annexed. Plate V. Fig. 2.

The ſquare is fortified the ſame way, excepting the angles of the polygon, being more open, in proportion to the number of ſides, the line of defence is drawn from the middle of the whole front, that is, from a point taken one third on the curtain, counting from the demi-gorge to the angle of the adjoining half baſtion.

I ſhall not here produce a multiplicity of examples, nor extend to irregular figures, much leſs to thoſe fortified with whole baſtions; it is for the uſe of young engineers I write; as for thoſe who have made this their principal ſtudy, I have perhaps, ſaid too much. Plate V. Fig. 3.

V. Forts, open at the gorge, ſerving generally to cover the heads of bridges, are ſeldom left to their own defence.

For which reaſon, when the bridge is not made, they are commonly conſtructed at the

the middle of an elbow, which forming a kind of arch, have a better defence than a right line.

If the river is narrow, and the oppoſite ſide as high, or higher than that on which the work is, detached flanks are raiſed, whoſe effect is the more certain, becauſe the ſoldier is leſs afraid of being attacked there.

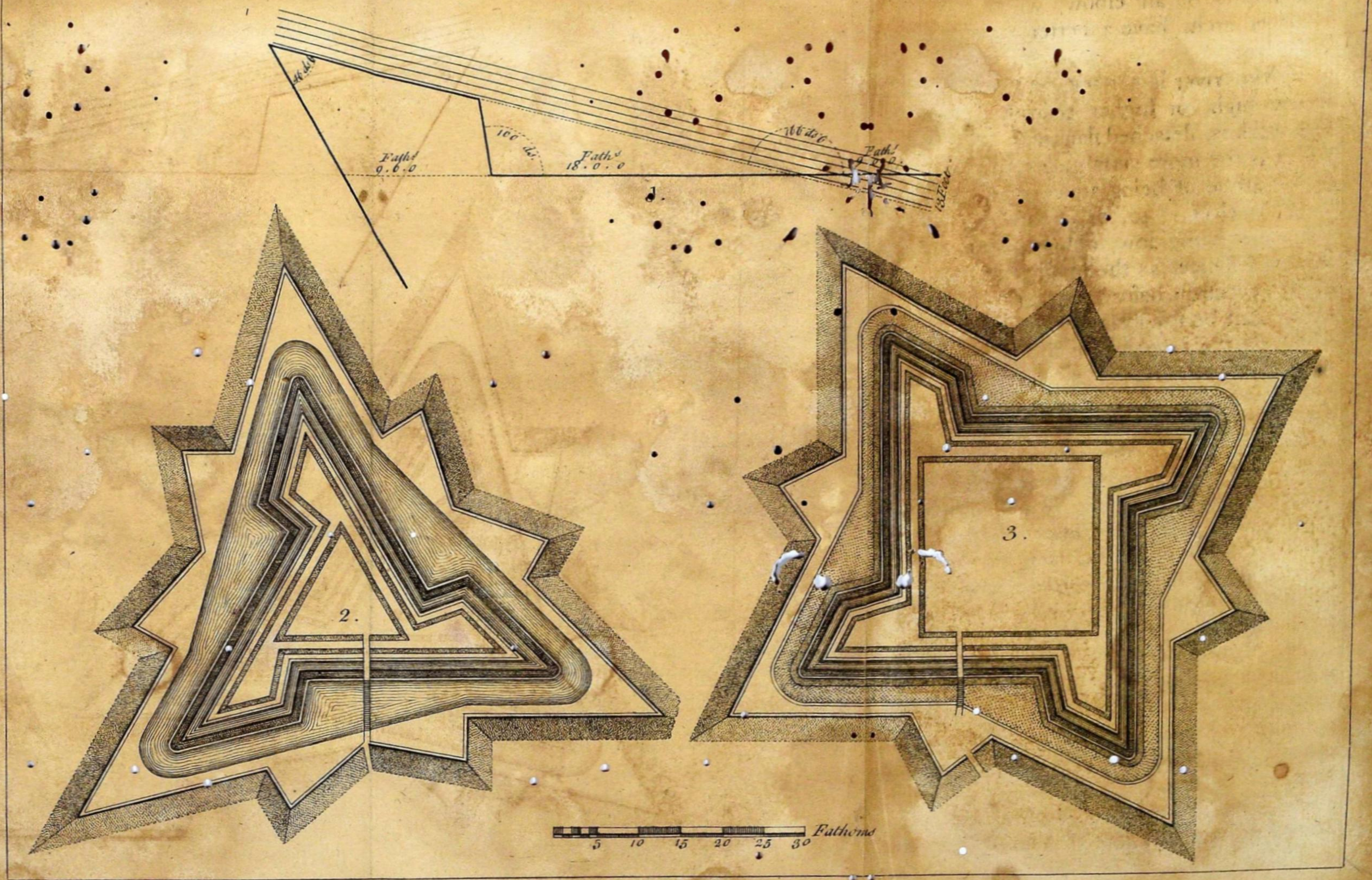
If the river is 40, or 50 fathoms wide, or the ſides being low, oblige us to retire to ſuch a diſtance, as the ſmall arms can do no great execution before the ſaliant angles, the faces muſt be ſupported by flanks, which are raiſed on the ſhoulders of the work, or flung up at the inſtant of the attac, that is, when the enemy is near the ditch. We cannot ſometimes uſe this reſource.

The *Rhine* below *Straſbourg*, the *Danube* below *Ingolſtat*, and many other rivers, are above 100 fathoms broad, in which caſe, we muſt not expect any protection from ſmall arms, from one ſide of the river to the other, but the flanks before mentioned will always be uſeful, if ſome pieces of cannon are placed in them.

As artillery is abſolutely neceſſary in this caſe, and certainly the moſt proper arms to defend the acceſs to a work at a diſtance, we ſhall not find them leſs neceſſary in the others. An engineer ought then to demand them.

VI. The ſize of theſe pieces is not determined by the number of men deſtined for their

BASTION'D FORTS



their ordinary guard, but rather, by that of the troops that are; or may be advanced; because they muſt be ſo conſtructed, that they may file off without confuſion, and muſt alſo favour their retreat.

The principal circumſtances, which can determine their figure, are reduced to three different caſes.

1ſt, When theſe pieces are near enough to be flanked from the oppoſite ſhore, a ſimple redan may be ſufficient: the inclination of the faces is regulated by the nature of the ground, and the parts to be commanded. There is nothing more to be obſerved, but in proportion as the angle differs from 90 degrees, the capacity of the work diminiſhes, and the more it is acute, the more direct and nearer its faces are protected. Plate VI.

When the defence is from ſmall arms, at a great diſtance, flanks muſt be added to the work itſelf, obſerving to ſcour the faces of theſe redans, from the other ſide of the river. Plate VII.

Theſe faces will not be too long, when the gorge is no wider than is neceſſary for an eaſy communication, the angle of the flank with the branches is about 110 degrees. I executed this at *Donaſtauf*, near *Ratiſbon*, in 1742, but I had not time to make the intrenchment in the iſland, which is very low; I ſuppoſe it here on a level with the country.

When we have no other defence than cannon, all parts of the work, except thoſe next the

river,

river, being equally expoſed, they muſt be as equally flanked as poſſible.

Pl. VIII. Fig. 1. Here are two works which may ſerve on ſuch occaſions. Form a ſquare; divide each ſide into four equal parts; take internally one of theſe parts for the capital; trace the curtain: take one of theſe parts for the gorge, draw the flank perpendicular to the line of defence.

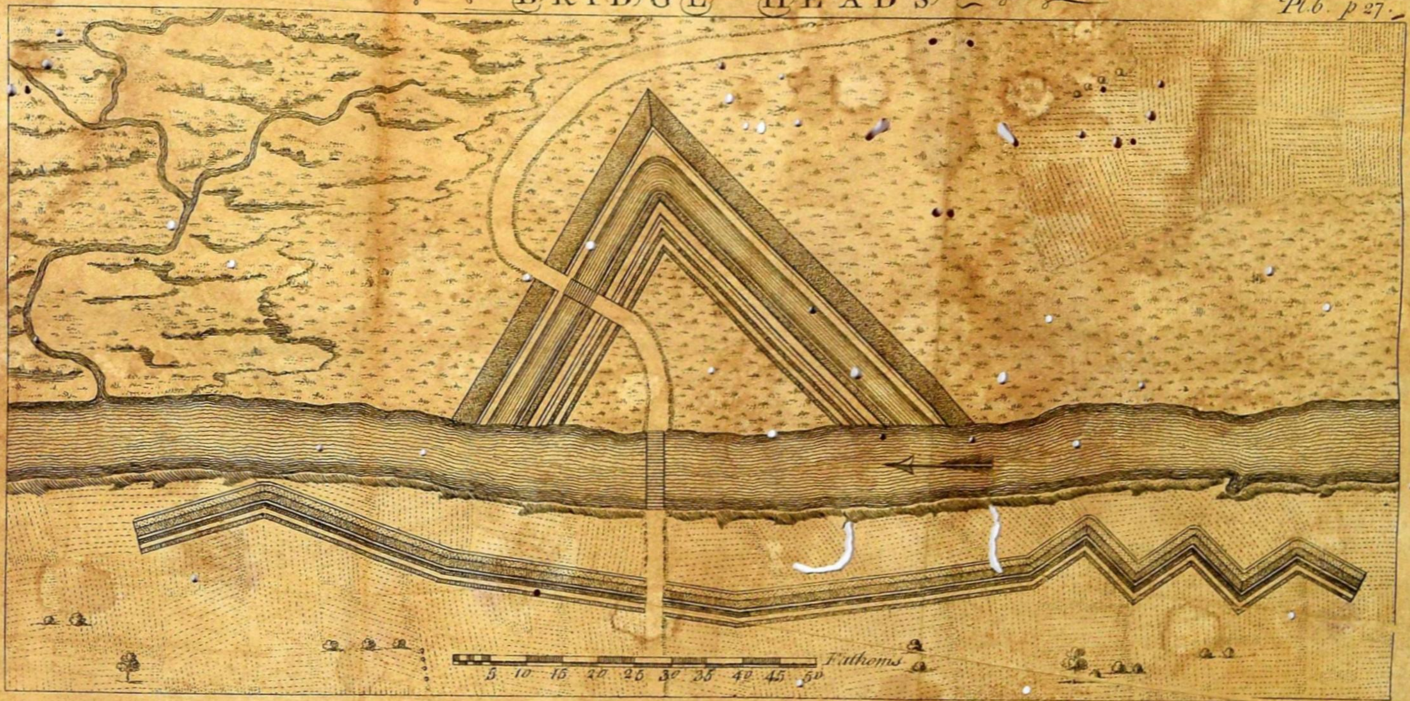
For the branch, give to the capital and the gorge, one fourth of the ſide, as in the front, except that the capital be carried externally: draw the line of defence from its extremity to the middle of the whole front; raiſe a perpendicular from the point of the gorge; prolong it internally half of its length, and from the point of prolongation draw the branch and flank, making an angle of 105 degrees.

As this figure differs in many things, from what has either been executed or publiſhed of this kind, I will add ſome reflections.

The flanks are very large, but the *Terreplein* being of a ſufficient extent, and the flanked angle open enough, I ſee no diſadvantage in this: thoſe of the front are perpendicular to the line of defence, not diminiſhing the faces too much in themſelves, have a good defence, as producing a croſs fire. The others are more open, to give the fire at the extremity of the branch, the more play.

The inclination of the branches is yet more particular; I draw two advantages from it.

BRIDGE HEADS



it: firſt, ſuppoſing the courſe of the river in a right line, their fire falls before one part of the demi-baſtion of the gorge; the ſecond, that the defence of the ſecond flank, which ſhould graze the faces, is leſs oblique.

The ſecond flank by this is ſhortened, but if we advert to the manner of eſtimating its fire, we ſhall find, that in regard to the grazing line, its effect is always the ſame.

The ſecond figure has its front traced as the preceding; cut off one ſixth of the opening of the gorge; carry two of theſe ſixths on the branch; and from that point forming an angle of 120 degrees, draw the face of the demi-redan. Pl. VIII. Fig. 2.

This method appears to me preferable to the firſt, if we are not to be protected from the other ſide of the river, as the branches are better defended: beſides, the flanked angles of the demi-baſtions are 62 degrees 6 minutes, which is ſufficient.

Theſe different heads of bridges, are to be eſteemed as good works againſt a ſudden onſet only, and their uſe almoſt momentary, as they ſometimes ſerve but for a few days, and at moſt during a campaign.

VII. There are ſome made more durable, ſuch as are commonly conſtructed before *Hunningen* and *Fort Louis*, and the enemy before *Philipſbourg*, at the beginning of a war againſt the emperor, or ſome other power of the empire.

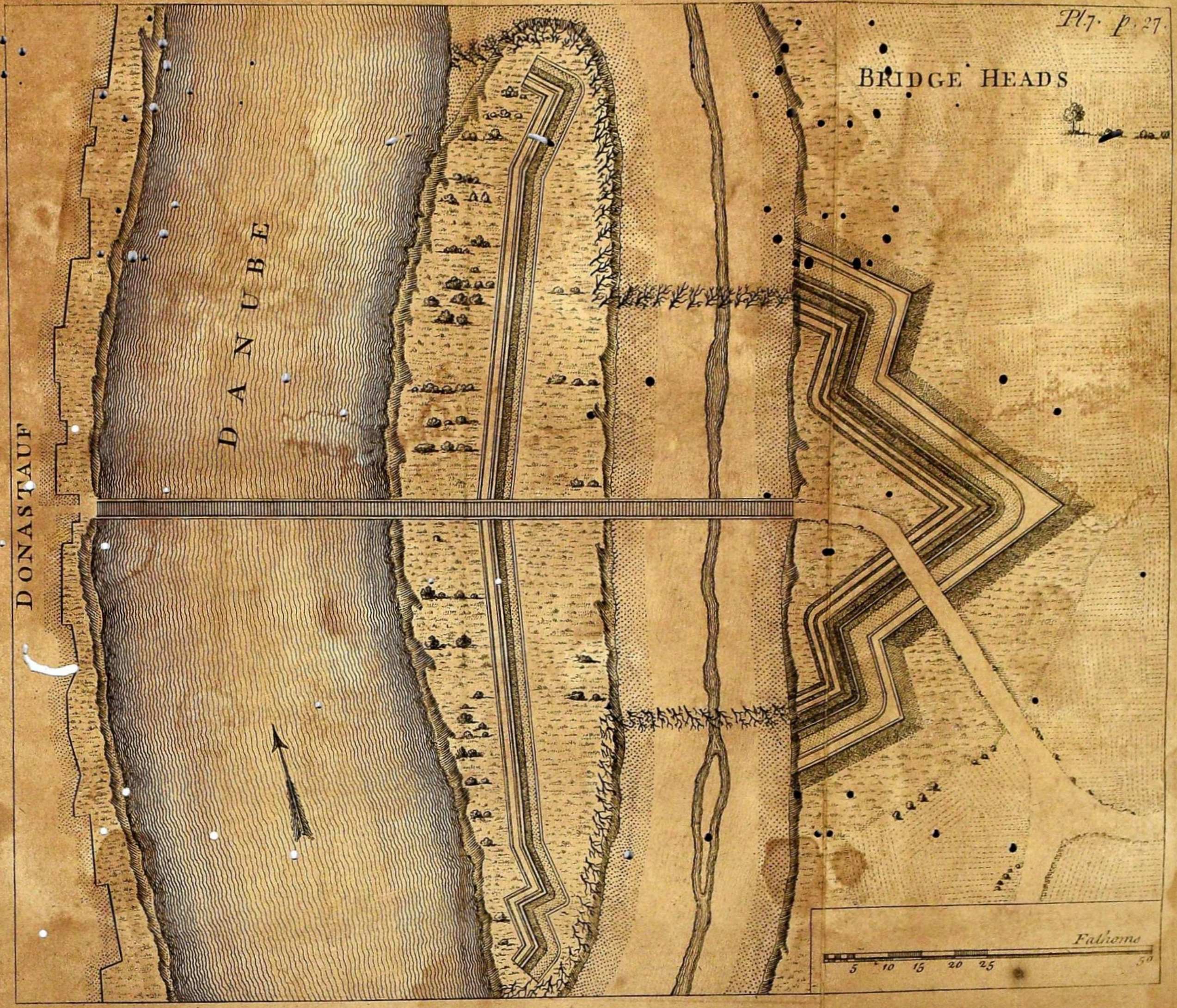
The

The only one I was ever employed in, was raiſed in 1733, after the taking of *Fort Keel*, in the iſland of *Selingen*. I was, as chief of the brigade, charged with its conſtruction, but I did not trace it; it was a horn work, and I do not ſufficiently remember its proportions, nor how the branches were defended, to give it here as an example.

We muſt obſerve in general, that as theſe little fortreſſes are deſigned to ſubſiſt till a peace, and ſeldom can expect any aſſiſtance but from ſome neighbouring garriſon, they muſt be not only conſtructed with ſolidity, but fortified, ſo as to ſuſtain a regular attac, long enough to be ſuccoured from a conſiderable diſtance.

That which covered the bridge of *Philipſbourg*, in 1734, was a horn work, of 45 fathoms in front, with a ravelin, and its branches, which opened and ſpread from the ſaliant angles, were flanked by demi-baſtions; we frequently find figures of this kind on the *Rhine*: if either of the conſtructions I have given ſhould be uſed in the like caſe, the front muſt either be more than 60 fathoms, or the faces longer, without which the ravelin will not be ſufficiently defended.

As theſe works are commonly planned and executed more at leiſure than the others, the whole art of fortifying places may be here practiſed: in 1742, I projected the half of a ſquare for the bridge of *Deckendorf*, the *Danube* forming the diagonal; but an epidemic diſorder


BRIDGE HEADS
DANUBE
DONASTAUF
Fathoms
5 10 15 20 25 50

diforder raging at that time amongft the foldiers, were left fcarcely fufficient for more indifpenfable Service. This figure is of great extent, and enclofes but little ground; circumftances, which joined to fome others, determined me to prefer one to it, which I fhall mention hereafter.

This half fquare was conftructed according to M. *de Vauban's* Method, excepting, that having no reafon to fear the line of defence would be too long, I fhortened the faces, to lengthen the flanks, which I made, for the reafons already mentioned, perpendicular to that line.

The front of the polygon was 60 fathoms, which is the leaft this figure can have, even for a field fortification. They will be acknowledged right, if we reflect on the fmallnefs of the flanks and *Terreplein*.

The work which covered the head of the bridge at *Philipfbourg*, after taking that place, made by the *Dauphin* in 1688, was larger, but fimilar to this.

VIII. A work, of what kind foever, is only fortified, in proportion as it has flanks, and in the different cafes mentioned, we may not always be able to give them as much extent as neceffary, without too much diminifhing the figure: the proximity of a morafs, a rivulet, a low ground, the neceffity of occupying eminences, efpecially for the faliant angles, without which, the branches, and perhaps

perhaps even the *Terreplein*, are expoſed, are obſtacles often very difficult to ſurmount.

This reflection gave birth to an expedient, which I had formerly propoſed to the court for a different uſe, which is, to equip two boats, with two pieces of cannon in each, and as many ſmall arms as ſhall be judged convenient; when boats cannot be found large enough, many may be faſtened together to form pontoons.

The movement of this machine is the ſame as our common ferry-boat, that is, by making a cable paſs on two turning cylinders, or rings faſtened to its ſide, one end of which is faſtened to the bridge, and the other to an anchor, caſt at ſome diſtance in the river.

If the current is not very ſtrong, the cylinders, or rings, are faſtened one on each ſide, ſo as to give the ſide of the boat its proper direction; but, if it be ever ſo little rapid, the boat muſt have its head to the current, or it will be in danger of being drove on ſhore. A parapet of madriers, or double planks, may be made, if judged neceſſary.

If the attac is made with cannon, theſe moveable flanks are brought behind the gorge of the work, and do not appear till the enemy ſhall be near enough, that they may have their full effect. The ſurprize, which the unexpected ſight of thoſe floating batteries, will produce in the aſſailants, is another advantage, and if they do not put them into diſorder, they will probably ſlacken their ardor. I ſuppoſe

I suppose here, the river is not so buried in its banks, but that we can command the country from the platform of the boats. This scheme struck me at *Deckendorf*; it is practicable on the *Danube*, in almost every part I have seen; the following year arriving at *Wormes*, I found it done on the *Rhine*, but in a less perfect manner, for the boats were fixed.

The great defence, and above all the surprize, were the only objects I proposed at *Deckendorf*, where, by the uniformity of the ground, I could have given what figure I pleased to the work: but I believe this expedient is not confined to circumstances.

IX. We frequently employ these vessels in places for other uses; they may also be of service in the field, but as this concerns the engineer only, as he may be obliged to defend himself against them, I shall content myself with some examples to support what I have advanced.

I saw at St. *Omers*, in 1710, or 1711, boats armed with one cannon, whose carriage turned on a pivot, as occasion required; they had at the same time galliots on the inundation of *Conde*, and some were built in 1735 at *Strasbourg*. It is well known, that when the *Imperialists* were at war with the *Turks*, they had whole fleets of * *Saiques* towards *Belgrade*.

 The

* *Saick* or *Saique* is a *Turkish* vessel, with a bowsprit, mall mizen, and a main-mast, which, with its maintop-mast,

The *Auſtrians* had them in *Bavaria*; and as the rout from *Nieder-Altach* to *Deckendorf* is croſs an even and open plain, ſtraitened in ſome places by the *Danube*, and mountains, our army would probably have been diſturbed in their march of the 18th of *Auguſt* 1742, if count *Thoring*, who in concert with count *Saxe*, ſuddenly paſſed the *Iſer* at *Pladling*, had not by that bold ſtep obliged M. *Khevenhuller*, to turn all his attention and forces that way. The *Saiques* did not appear till two days afterwards; they concealed themſelves, to the number of 10 or 12, under cover of an iſland, which is at the mouth of that river, from whence they cannonaded our guards of cavalry, and annoyed our bridge; the huſſars and pandours over-run the plain: I had propoſed on the 30th of the preceding month, to raiſe a battery on that iſland: it was at length done, and we ſaw nothing afterwards, either on the plain, or the *Danube*, to the night between the 5th and 6th of *September*, when we decamped to join the army of M. *de Maillebois*, by the rout of *Bohemia*.

OBSERVATIONS on the ſecond chapter.

The conſtructions of forts and bridge-heads, having been very little taken notice of by writers, our author, judging them very uſeful

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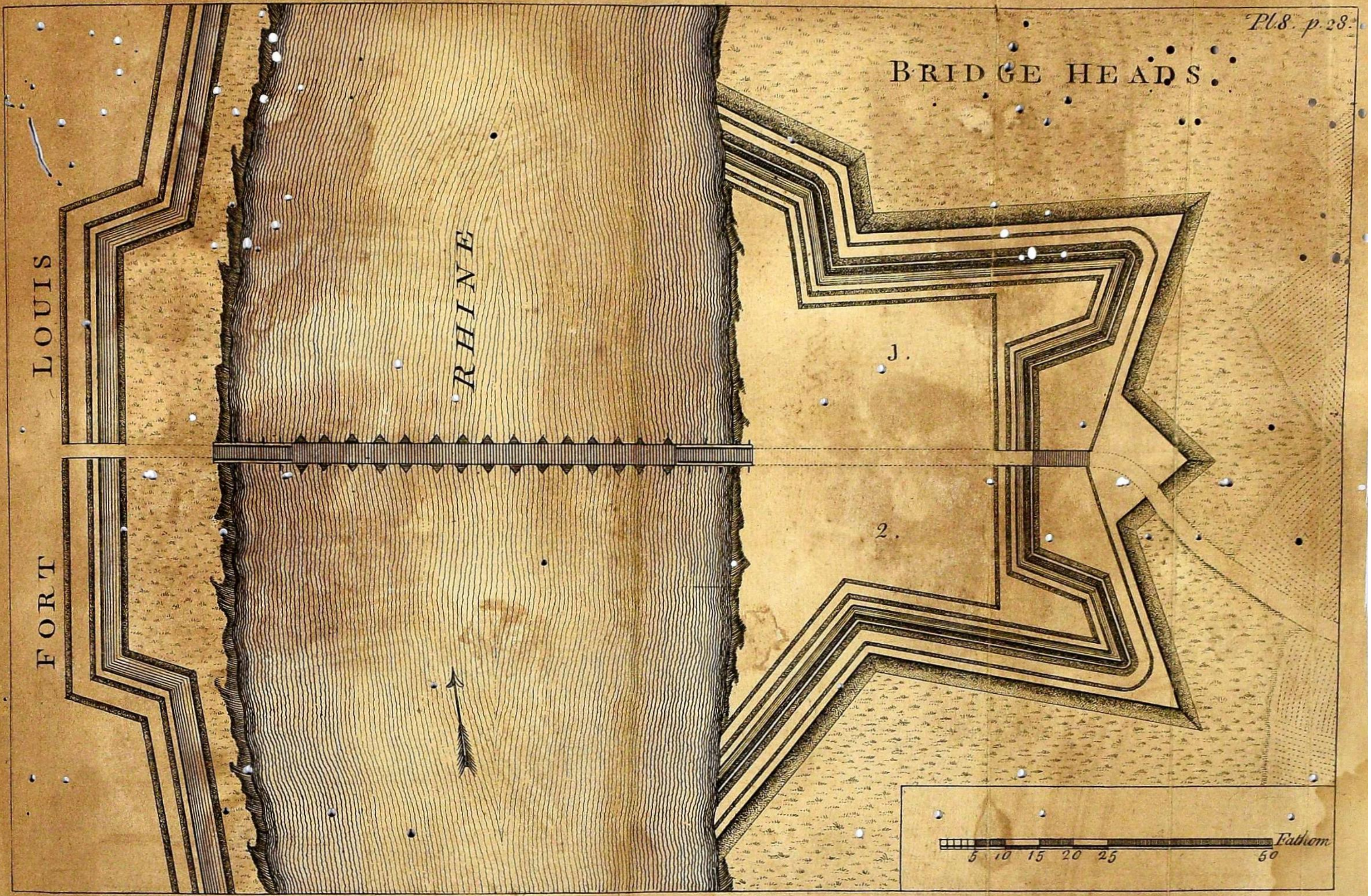
maſt, is ſupported at an extraordinary heighth, by ſtays from the topmaſt, to the bowſprit and ſides.


BRIDGE HEADS.
FORT LOUIS
RHINE
1.
2.
5 10 15 20 25 50 Fathom

ful and abſolutely neceſſary, treats of them here: and as his method is ſomething particular, and ſuppoſes the reader to be acquainted with the common practice, which not being always the caſe, we thought an explanation would not be altogether uſeleſs, eſpecially to beginners.

After the redouts, the forts with points or ſaliant angles, commonly called *ſtar forts*, are the moſt ſimple, that have ſome defence, though very oblique; they are made from four to eight points: the ſquare one is con- Plate A. ſtructed, by making the perpendicular FE to Fig. 2. the middle of the ſide AD, equal to one eighth part of that ſide; but in the pentagon this perpendicular is one ſixth part of the ſide. In the exagon, an equilateral triangle is made upon each of the ſides.

The octagon may be traced in the ſame manner as the exagon; that is, by making an equilateral triangle upon each ſide: but as this conſtruction is ſomewhat difficult in the practice; the author gives the following one: find the ſquare one ABCD as before; divide Fig. 2. each of the ſides AE, DE, into three equal parts, and make upon the diſtance between the points of diviſion G, H, next to the point E, an equilateral triangle, which forms the angle GLH. As to the *ſtar fort* of ſeven points, it is never uſed, becauſe it is too difficult to trace on the ground.

As the defence of theſe forts is ſo very oblique, eſpecially in a ſquare, and the con-

ſtructions of the others require too much time and workmanſhip; they appear to me ſcarce worth while to be made, excepting on ſome very particular occaſions. The forts next in rank are thoſe with half baſtions; which are not much better than the former, as having their faces very little defended; the conſtruction of the triangular one is; take the part AD of an equilateral triangle ABC, equal to one fourth of the ſide AC, draw BD, in which take DE equal to DA, and draw the flank EF at right angles to BD; then AF will be the face of the half baſtion, and EB the curtain.

Plate A. Fig. 3.

Inſtead of half baſtions, I would make whole ones, placed in the middle of the ſide, as in this figure; where the gorge DC and the capital EF are each one fifth part of the ſide AB; the flanks are perpendicular to AB, and equal to one tenth part of the ſide, or half the gorge. By this conſtruction, the ſaliant angle F is a right one, which is preferable to any other; and there is no part but what is ſeen and defended by ſome other; the ſecond flank which defends the face is four fifth of half the ſide BE; and therefore the direct flank BL is about two fifths of BE nearly. Beſides, as this figure is more regular than the former, it will contain a greater ſpace within the ſame incloſure.

Fig. 4.

Fig. 5.

The conſtruction of the ſquare fort is; produce the ſide DC to E, ſo as CE be equal to one third of DC; divide the ſide BC into three equal parts in G, H, draw the line of defence

defence EH and the flank GF perpendicular to the ſide BC. Although the faces of this fort are defended by a ſecond flank equal to half the ſide of the ſquare, yet on account of the great difficulty of firing ſo obliquely over a parapet of 8 or 10 feet thick; the following fort with whole baſtions is preferable, and is alſo more practiſed. Make the perpendicular CD to the middle of AB, equal to one tenth of the exterior ſide, and the faces AF, BG equal to one fourth of that ſide: the flanks are drawn at right angles to the lines of defence. Fig. 6.

The bridge-heads are made of various figures and ſizes, ſometimes like a redan or ravelin, with or without flanks, ſometimes like a horn or crown work, according to the ſituation of the ground, or to the importance of its defence. Their conſtruction depends on various conſiderations; when the river is ſo narrow, that the work may be flanked from the other ſide, a ſingle redan is ſufficient, but when the river is ſo broad, as that the ſaliant angle cannot be well defended croſs the river, flanks are made to the redan: but if the river is a 100 fathoms or more a-croſs; half a ſquare is made, whoſe diagonal is the river ſide: but when it is from 3 to 500 fathoms broad, a horn or crown work is then to be made.

A river may be ſtrait or crooked; if it be ſtrait, the bridge is made before the middle of the front of the army; and ſometimes two at equal diſtances from the center and wings;

ſuppoſing the ground to be equally favourable, otherwiſe they are placed where it is moſt convenient.

Fig. 7. If the river be crooked, the inward bend is to be choſen; for ſuppoſe a, b, c, to be its courſe, if the bridge is made at b; the enemy cannot ſee, or flank it from any part on the other ſide; the batteries placed at K and L flank and defend not only the faces of the head P, but likewiſe all the part D, E, about it; by which the troops may march out, and draw up in order of battle, without the enemy having it in his power to diſturb them, but at a great diſtance. On the other hand, if the bridge was made at the outward bend as at a or c; it would be enfiladed from both ſides, the head could not be defended but from a great diſtance, and very obliquely; and the troops could not form before the work, without danger of being charged immediately by the enemy. Therefore ſuch a ſituation ſhould be avoided if poſſible.

Fig. 8. When the river is narrow, a triangle ABC is made upon the bank AC of the river, ſo as the ſaliant angle B, may not exceed a right angle, nor be leſs than 60 degrees; which may be done at ſight, without the help of an inſtrument: as to the length of the ſides AB, BC, it depends on the number of men to defend it. For inſtance, ſuppoſing three rows at three feet diſtance from one another; then ſix times the length of one face expreſſed in yards, will be the length required. If therefore

fore each face is 50 or a 100 yards; it would require 300 or 600 men to defend it: besides a body to support them, and to supply the places of those that are killed and wounded.

If such a work requires flanks, take AE equal to one fourth of AB, erect the flank EF perpendicular to AB, and equal to AE, draw the line of defence BF, which, when produced, determines the face FD.

But when the river is so large, that no defence can be expected from the other side: construct half a square ABC, in the same manner as in the sixth figure, and so as the diagonal AC be the river side. Fig. 9

When the bridge is to remain during the course of a war, such as that built at *Fort Louis* upon the *Rhine*; it requires a larger work than the preceding ones: for which reason, a kind of horn or crown-work is to be made, or such as is represented in this figure, which is thus constructed. Let ABCD be a square, take BE, CF, each equal to a fourth part of the side, draw EF, in which take the parts EG, HF, each equal to one fourth also, or to BE, and CF, draw the lines of defence BH, CG, and the flanks GL, HK, perpendicular to CG, BH the lines of defence. Fig. 10.

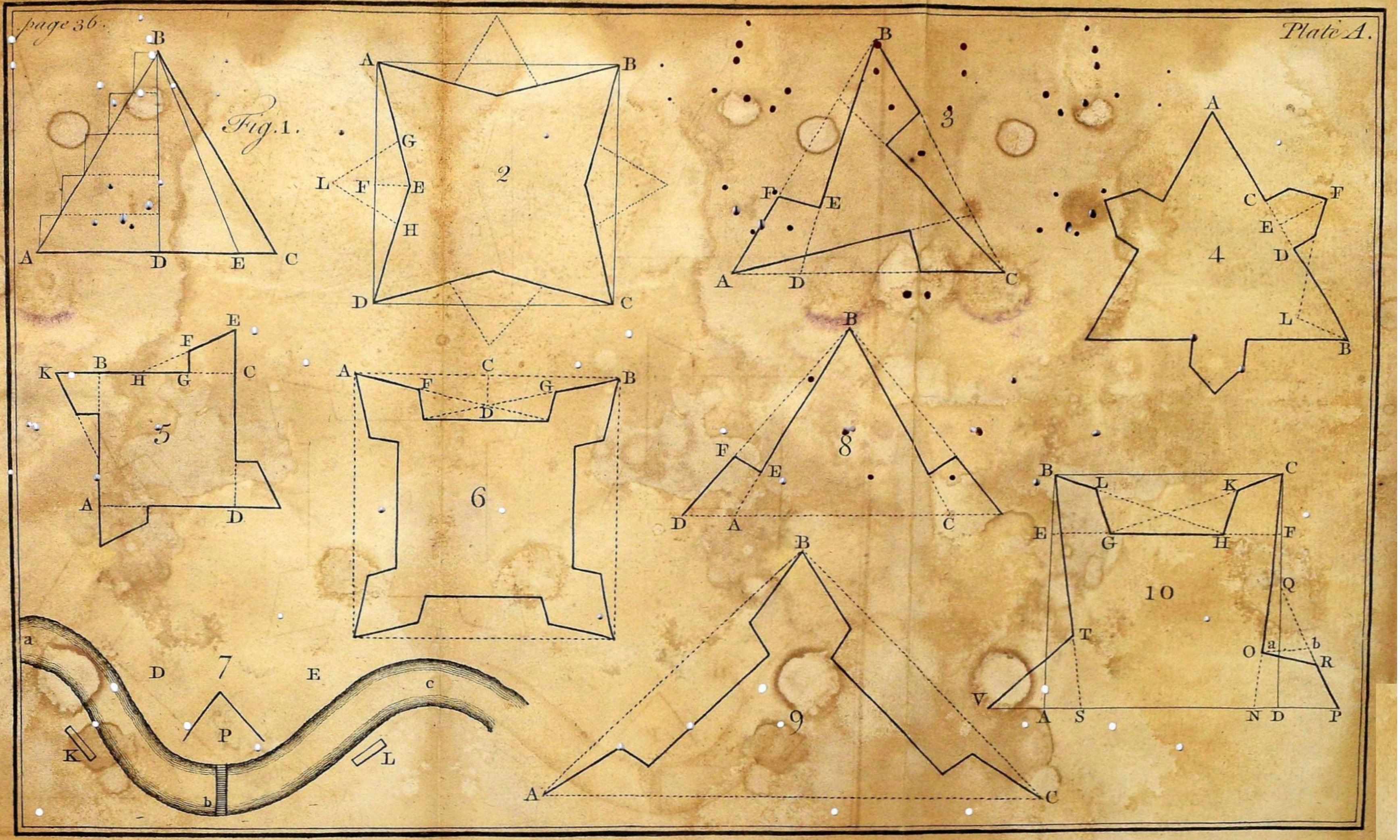
The branch PROC is constructed, by setting off from the point D, the part Da upon DC, and DP upon AD produced, each equal to one fourth part of the side AD; take aQ

equal to Da, and draw the line of defence PQ: then if through the point a, the line bO be drawn at right angles to DC, and aO be taken equal to half of ab, the curtain CO is drawn to that point; and the flank OR at right angles to it, or ſo as to make an angle of 105 degrees. The ſecond manner of conſtructing the branches is, to take AS on AD, equal to one ſixth part of the ſide, and in BS, the part ST equal to twice AS; from the point T, the flank TV is drawn ſo as to make the angle BTV equal to 120 degrees.

This ſecond method is eſteemed by the author preferable to the firſt, but in my opinion ſpreads its fire too much: the firſt conſtruction is more troubleſome than the ſubject requires, and does not agree with the authors profeſſed ſimplicity: it may be done thus; take DN on AD equal to one ſixth of that ſide, as has been done on the other ſide, draw CN, in which take NO equal to one fourth; then the flank OR is drawn either at right angles to CO, or ſo as to make an angle of 100 degrees; and equal to NO.

This front muſt be covered by a ravelin, ditch and covert-way, as well as all works of this kind that are to remain for ſome time. When an iſland is to be found in a large river, the bridge is to be made there; becauſe it ſhortens it, and an intrenchment may be raiſed, either to defend the head, or to cover a retreat; ſuch kind of ſituations are frequently found on the *Rhine* and *Da-*

nube,


page 36.
Plate A.
Fig. 1.
B
A
D
E
C
2
A
B
G
L
F
E
H
D
C
3
B
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nube, and they are not neglected by the *Germans* or the *French* when they cross these rivers.

CHAPTER THE THIRD.

I. *Examples of the manner of fortifying a church-yard.* II. *A church.* III. *An old castle.* IV. *A country-house.* V. *Attack of a country-house.* VI. *Various instructions on the different subjects of this chapter.*

I. BEsides posts, which require the works we have spoken of in the preceding chapters, there are others which do not less demand our attention and judgment. They are fortified according to the time, numbers, and means we are masters of, and the use we would make of them: I shall explain myself better by examples.

The first of *October* 1742, having set out with twenty-one engineers, from the camp of *Bramerhof*, to go to *Amberg* the next day, three leagues below *Tirschenreit*, we found a considerable body of hussars, waiting for us at the end of a wood, and who at first kept at a distance, seemingly the better to reconnoitre us.

Our escort consisted of thirty-three men of the independent company of *Limont*, for the most part badly provided with pistols, and our baggage liable to put us into confusion, yet

yet being determined to go forward, we passed thro' the village of *Pfaffernreit* without stopping.

Scarcely were we got out, when the hussars, who had taken a tour round it, briskly attacked us with pistol and carabine; this did not prevent us continuing our journey with a slow pace, and in good order, 'till we were opposite to *Miteldorf*.

This skirmish lasted above an hour; two engineers were taken, one of whom was wounded, another was also wounded, with four domestics. The enemy did not suffer less, but they were not discouraged, their number encreasing every moment; the more we advanced, the less hopes we had of assistance: these circumstances determined us to throw ourselves into the village.

We soon saw that this was no asylum for us; we found neither church nor walls to enclose us; this place consists of a dozen houses of wood, or deal planks laid on one another, and pinned at the corners, according to the custom of that country. We had all the dreadful effects of fire to fear, a kind of attack very inhuman, yet customary with the people we had to deal with, and who were encouraged by a considerable sum, which they found on one of the prisoners; this made us certain, that if they quitted us, it was only to return in a little time with a greater body.

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In this dilemma, we reconnoitred and reached *Vurz*, a village, in which we perceived a ſteeple, and which was about the eighth part of a league on our right.

Having carefully examined the avenues, and barricaded them with trees, baggage waggons, carts, *&c.* from each of which we took a wheel or two: we raiſed a banquet along the wall of the church-yard, where we fixed with our baggage; making uſe of the church, in the door of which we had cut loop-holes, as a citadel, and the ſteeple as a redout, which muſt be our laſt ſhift.

Two ſtone houſes almoſt touched our bounds, but being built on very low ground, the height of their walls did not exceed that which ſerved us as a parapet. We would not open theſe walls, and yet we muſt have a communication with thoſe houſes; the poſſeſſing them was abſolutely neceſſary, as well to avoid being overlooked, as to give us ſome flanks. We therefore judged it beſt to conſtruct our communication in form of a bridge, from the top of the intrenchment into the roof, and having barricaded the doors and windows in the lower floor, we here fixed ſome guards.

I thought the recital of what we did upon this occaſion, might ſerve as an example how to act upon a like occaſion: altho' our precautions were prudent, they happened to be uſeleſs; for the huſſars, being tired of waiting for us on the road, went off in order to return the

next

next day in a greater body; but in the mean time, after we wrote every where for ſuccour, and could get no more than fifty men of the ſame company, and who had orders to go no farther; we retired, and got to *Tirſchenreit*, before they returned.

II. The church of *Vurz* was doubtleſs a more ſecure poſt than the church-yard; but as we would not abandon our horſes, nor put them into the church, this retreat required works which we had neither time nor means to execute.

When a church is to be defended, the doors muſt be covered with breaſt-works, of thick pallifades, joined or lined with planks: the loop-holes muſt be ſix feet high at leaſt, that the enemy may not reap any advantage by them: the earth of a little ditch which ſurrounds it, ſerves to form the banquet.

The doors and walls muſt alſo have loop-holes, or, if the walls be too thick, make them in the windows; this ſuppoſes a ſcaffolding, which ſhould run round the whole building, to facilitate a communication from one part to another.

If the church be in form of a croſs without, it in part flanks itſelf; if not, the veſtry at leaſt flanks one of the long ſides, and the breaſt-work ſhould be ſo diſpoſed as to produce the ſame effect on the other.

There remains then only the rear of the choir, abſolutely defenceleſs, this is remedied

by

by piercing a ſecond row of loop-holes, low enough to diſcover the adjacent parts before it; or elſe project from the windows and the roof, (and as high as poſſible for fear of fire) ſome little *Machicouliſes* of wood.

If the ſteeple does not afford the ſame advantage as the veſtry, it may ſerve at leaſt to ſee what paſſes at a diſtance, and as a redout to capitulate in, in caſe ſuccours do not arrive in time. The church of *Berg*, a village in the neighbourhood of *Lauterbourg*, was intrenched in this manner during part of the war, terminated by the treaty of *Radſtat*.

III. Caſtles, and large well-built country-houſes, are to be preferred to churches, becauſe greater advantages are commonly derived from them.

I ſhall explain myſelf by what I have ſeen; this manner of inſtructing, I am ſenſible, flatters an author, but rouſes the reader's attention, who generally has more regard for the recital of facts, than to ſimple precepts.

The firſt caſtle I had orders to reconnoitre was that of *Natterburg*, half a league from *Deckendorf*, on the *Danube*.

It was the ruin of a conſiderable fortreſs Plate IX. for a private man: it poſſeſſed the whole ſummit of a very ſteep hill, which was long and ſloping, and almoſt every where of an equal breadth: the buildings were in ruins, but the ſurrounding walls were ſolid and well preſerved.

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In the plan annexed, no flank can be feen in the furrounding wall, becaufe in my paffage through I difcovered none, perhaps, by not being able to penetrate into fome places encumbered and obftructed by the falling of the floors and roofs; but the fteepnefs of the hill on three fides, and the other, that is the extremity of the *Efplanade* being of little extent, and furnifhed with a ditch, fupplied this defect.

One very material circumftance was, that the walls of the fore-court were about 15 feet high, and thofe of the caftle more than 30, and were not made with loop-holes.

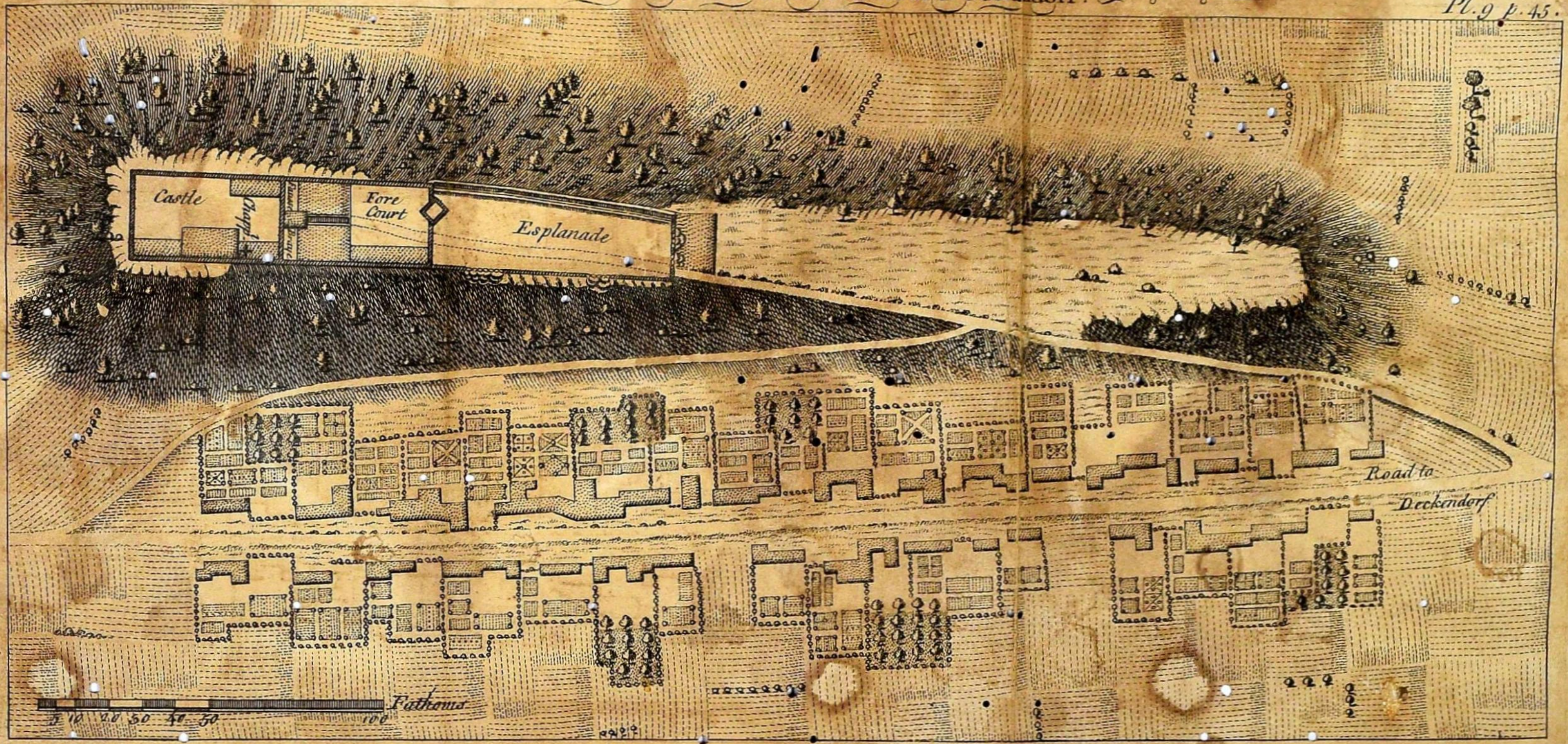
This little fortrefs, as may be feen, cannot be attacked but on the front of the *Efplanade*, which the firft builders had in view, at leaft we may judge fo, by the different walls, which muft be broke through, or got over, on that fide, before it can be taken.

It will therefore be fufficient, to erect two fcaffolds, at the two angles of the rear of the caftle, fo high as to difcover what paffes over the furrounding wall, and fo difpofed as to flank the three fides, if neceffary.

In regard to the principal walls of the front, *viz.* Thofe of the caftle, the *Faufsbraye*, and the fore-court, muft have banquets, platforms, and loop-holes, likewife holes made in the moft convenient places, large enough to ferve for embrafures for fome fmall pieces of cannon.

It

NATERBERG a Castle near Deckendorf.



It is alſo abſolutely neceſſary to repair the breaches in the wall of the *Eſplanade*, with dry ſtones, or to cloſe them with palliſades, to palliſade the bottom of the ditch, to fraiſe the parapet of earth, and to render the road impaſſable, when the enemy approaches, by felling trees, *&c.*

This poſt, thus repaired and provided with ſtores, with 3 or 400 men for a garriſon, would be in a condition to ſuſtain a ſiege.

IV. The firſt of *Auguſt* in 1742, I received orders to fortify the caſtle of *O*, a country-houſe, ſituated between *Deckendorf* and *Regen*, from which it is about a league diſtant.

My works were neither remarkable for their ſingularity or expence, they were indeed trifling, but the action which I ſhall ſpeak of, proves that theſe trifles were ſufficient, and the detail may be of ſome uſe to a young engineer, or one who has had little, or no experience in this part of his duty.

This caſtle is built on the ſummit of an eminence, the acceſs to it impracticable on one ſide, and very difficult on two others: the plan annexed, which muſt be attended to in reading the ſequel, will explain the reſt.

My firſt attention was to maſk the doors with breaſt-works of firr-plank, planted one againſt the other, and elevated without from 8 to 10 feet, juſt as I found it neceſſary to cover the adjacent heights, and made loop-holes at every three feet.

 Theſe

These breaſt-works, whoſe ſides flanked where it was neceſſary, have a banquet, and that of the great gate, the only one not cloſed up, a barrier of planks with loop-holes.

The rear-court and the barn had no communication with their breaſt-work, but what were ſo low, as not to be diſcovered from without.

All the exterior openings, for 9 or 10 feet from the ground, were at the ſame time walled up, to guard againſt fire, a common expedient of the enemy; and, as we did not want planks, I ordered the windows to be maſked, 6 feet from the floor, to cut loop-holes in them, and in the doors.

Such were my general precautions; the top of the little barn, and the walls of the great one were of good maſonry, and our breaſt-works defended this front pretty well, the only one eaſy of acceſs.

The ſide next the river, was incloſed with high ſolid walls, acceſſible only on the ſide oppoſite the bridge, and flanked by the bog-houſe, the tower next to it, and the breaſt-work adjacent to the tower: there was nothing to fear in the rear, and the ſides of the brew-houſe were carefully built on a ſteep rock.

From thence to the pavilion, and from the pavilion to the little barn, the wall was from 6 to 7 feet high, along which we threw up a banquet: this ſide being weaker than the reſt,

reſt, I ordered ſome loopholes to be made in theſe buildings: from the brew-houſe to the pavillon, the hill is very ſteep, but of an eaſier aſcent afterwards: the garden on the outſide was encloſed by planks nailed to poſts; I ordered it to be pulled down, and alſo a dry ſtone wall three feet high, which parted the terraſſes, and which would have ſerved the enemy for a parapet, by kneeling on the ground: theſe two terraſſes I ordered to be made into a glacis, and every thing to be cut down that might obſtruct our view.

The little barn, with which I ſhall finiſh the deſcription of the incloſure, was certainly the moſt dangerous place, becauſe three of its ſides were of wood, and I was afraid, that if the enemy ſet fire to this, it might communicate to the great one, which was much higher, but covered with ſhingle, or cleft wood.

In my report, I propoſed to pull it down, and cloſe that ſpace with a breaſt-work of the ſame conſtruction as the reſt, and turned ſo as to flank the adjacent parts; I ſhould have done it of my own accord, but the deſign being to make this caſtle a magazine of forage, we were obliged to preſerve places proper for concealing it from the ſight of the enemy, ſince we could not keep them at a proper diſtance: I therefore ſupported a parapet of well beaten earth, by the wall of the garden, and where the ſlope would not per-

mit that, I doubled it with a brick wall, built with clay, inſtead of mortar.

If I have explained myſelf as clearly as I could wiſh, it will appear, that the ſide of the garden was the only place that could be forced without cannon; and if the enemy had got over this wall, which was almoſt intire, I will venture to ſay, they could not advance much further.

By raiſing a new breaſt-work on the ſide of the court, and opening ſome old doors, I had a free and ſure communication through the ſtables, from the caſtle to the great barn, and its breaſt-work; it was poſſible to prolong this communication even to the brew-houſe, by a row of paliſades, but that was a conſiderable encreaſe of work; a wall muſt alſo have been broke through, which was not without its inconveniency, and the brew-houſe high, and ſolid built, was in a very good ſtate to do without that aſſiſtance.

All the windows and doors of the buildings being ſhut up to a proper height, and loop-holes made in them, it is ſufficient to caſt an eye on the plan, to be convinced, that the moſt obſtinate enemy, could not keep their ground in the court, croſſed by ſo many fires.

V. A ſuccinct account of what paſſed a few days after, will the better juſtify theſe precautions.

The 9th of the ſame month, in the afternoon, this caſtle was inveſted by about 800 men,

men, from the garrison of *Passau*, and the camp of *Mr. Kevenhuller*, among them were 400 grenadiers, some pandours and hussars.

M. Darmeville, captain, commandant of a battalion of *Picardie*, held this post with 50 men, the independent company of *Regen*, and 80 dragoons of that of *Jacob*, who, being prisoners of war, were of no service: the *French* commandant was often summoned to surrender on honourable conditions; there also came an hostage to him, that he might send and reconnoitre the number and kind of troops by which he was invested. *M. de Poussac*, captain in the regiment of *Normandy*, one of the detachment, was charged with this commission: he found the 400 grenadiers behind a hill, but neither this, nor the confusion of so many horses in so small a place, nor the fear of the forage, scattered up and down the court, could damp the resolution of these officers.

The sight of the breast-work, which almost covered the front, made that side appear not very easy of access; the enemy therefore attempted the attack opposite the mill, which they burnt; their design was likely, to climb up under cover of the brew-house, and slip along the surrounding wall, but finding the slope so steep, and the pavillon loop-holed, they quickly turned to the weakest side, that is, towards the garden, where they had but one of these obstacles to surmount. The besieged, without the least hurry or

 confusion,

confusion, never fired but in good time, and by order of the commanding officer; they killed some pandours, who, supported by their small arms, attempted to set fire to the little barn in the night, with torches fixed at the ends of long poles. This ill success discouraged the rest; and finding they could neither set fire to the building, nor disorder our troops by their frequent discharges, they retired at one in the morning, to some distance, to consider what method they should take to succeed.

The thing was difficult without cannon, and *M. Saxe*, who had taken the command of the army, the same day of the attack, had not given time to bring any. This general being informed of what had passed, ordered a general forage, the next day on the left, where he marched in person: under this pretence, he detached by different roads, two corps of infantry and dragoons, who disengaged this post, and would certainly have either taken, or destroyed the 800 men who attacked it, if too much ardor had not prevented their strictly conforming to orders, of not appearing, but all at once, to cut off their retreat.

VI. If my design was only to give my own ideas, and treat of works of this kind, which I have executed, perhaps I should have nothing more to add here; but as my view is quite different, I shall finish this chapter with some observations, chiefly drawn from an author,

thor, who is the more clear on this ſubject, as he had frequent opportunities of experiencing them.

1. *M. de Folard*, the only one who has wrote on this head, prefers walls of brick, and even the thinneſt of them, to thoſe of ſtone, becauſe cannon only makes holes in them; and in ſtone, where it makes a breach, the ſplinters do great miſchief.

2. He recommends carefully to guard againſt fire, and conſequently, if the building is covered with thatch or boards, to pull down the covering and burn it immediately, leſt it aſſiſt the enemy in annoying you; as to the boards, they will always be of uſe.

3. He propoſes to ſtop up the door, eſpecially if it be large, with a tree or two, with all their branches cut and ſharpened at the ends, which he ſays, is better than the beſt barricaded door. This has certainly a good effect, but I do not ſee, why he would rather have the door open, as he afterwards mentions, than to have loop-holes in it: he ſays nothing of the windows.

4. He would have the loop-holes below, 3 or 4 inches wide, and 7 ½ or 8 feet from the ground, that the enemy may not fire through them, and about 2 or 3 feet diſtant from each other, that they may not get to the roof, without being expoſed; above all, he recommends to pierce the angles.

5. Beſides theſe loop holes, he propoſes others below, under the intervals of the up-

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per ones, and only one foot from the ground, digging a trench 6 feet broad, and 3 feet deep, 2 ½ feet from the wall withinside. By this means you discover the legs of the assailants, which when near, cannot be seen from the upper ones: this is an excellent thought; I would only recommend that they be even with the ground, and not more than 6 inches high: the trench need not be deeper, because they may fire kneeling. The banquets of the upper loop-holes must in this case be planks.

6. For fear the enemy should gain the roof, which we here suppose tiled, it must be scaffolded, so as to be defended by some holes made in it.

7. He advises to provide a number of stones, to throw down, especially at the angles, where the enemy will attempt to sap.

8. If for want of men, or other means, you are obliged to quit the lower part, he recommends, to use all possible means to keep the enemy out of it; therefore holes must be made in the upper floors, especially towards the doors, to fire down through: this *M. de Saxe* practised, when he defended himself a whole night in a country inn, with 18 men only, against a detachment of 200 dragoons, and 600 *Polish* horse, who could neither force nor take him, though wounded.

9. When you can only possess part of the upper rooms, *M. de Folard* proposes to break up the floors of those you abandon in many places,

places, at leaſt before the doors, a little more than their breadth, ſo that this opening may ſerve as a ditch; but it is neceſſary to have an eye below, leſt the enemy get through them by ladders.

10. Laſtly, if the doors are ſlight, and if they attempt to break them with hatchets, he would have you retire to ſome diſtance, and to keep firing at the place from whence the noiſe comes: it was thus practiſed in *Italy* at the defence of the caſtle of *Bouline*, 1705, celebrated by this action.

The reader muſt doubtleſs perceive, that the moſt part of theſe rules agree with the different articles of this chapter, by adding what I have ſaid on each in particular, I believe little more can be deſired on this ſubject. I ſhall however join ſome reflections on the attac, an object always to be had in view, when we are treating of the defence.

Suppoſing the poſt in condition, and ſufficiently provided with troops, and that the enemy have no cannon, they are then reduced, as *M. de Folard* obſerves, either to ſcaling the roof, undermining the walls, or making a breach with a beam, ſuſpended between four poſts like a ram; now it appears impoſſible to me, that any of theſe means can ſucceed, as long as ammunition laſts, or the defendants preſerve their ſenſes.

When you are obliged to abandon the ground-plot of the building, there is nothing to fear, in my opinion, but fire and ſmoak,

 things

things very difficult to guard againſt; it ſhould therefore be defended as long as poſſible.

But if the aſſailants have ſome cannon of 6 or 8 pound ball, and theſe placed out of reach of muſket-ſhot, it does not ſeem prudent to contend ſo obſtinately againſt a fire you cannot anſwer, unleſs you know aſſiſtance is at hand, or when ordered to defend it to the laſt extremity.

Farther, it muſt be remembered to defend the doors, as much as poſſible, to flank the walls, and to make the little *Machicoulis* of wood I mentioned, and to collect a number of ſtones; but being more apprehenſive of fire than ſapping, I would rather have a magazine of water.

Observations on the third Chapter.

In the courſe of a campaign many circumſtances may happen, where the ſagacity and knowledge not only of engineers, but alſo of every individual officer who commands or may command a party, may be diſplayed to his reputation, and the great advantage of the public. For when an army is not ſtrong enough to venture a battle, or ſome other reaſons require it to be upon the defenſive only, poſts are to be taken to reſtrain the enemy from ravaging the country; parties are ſent to fall upon convoys or ſtragglers in foraging; and to lay hold on all opportuni-

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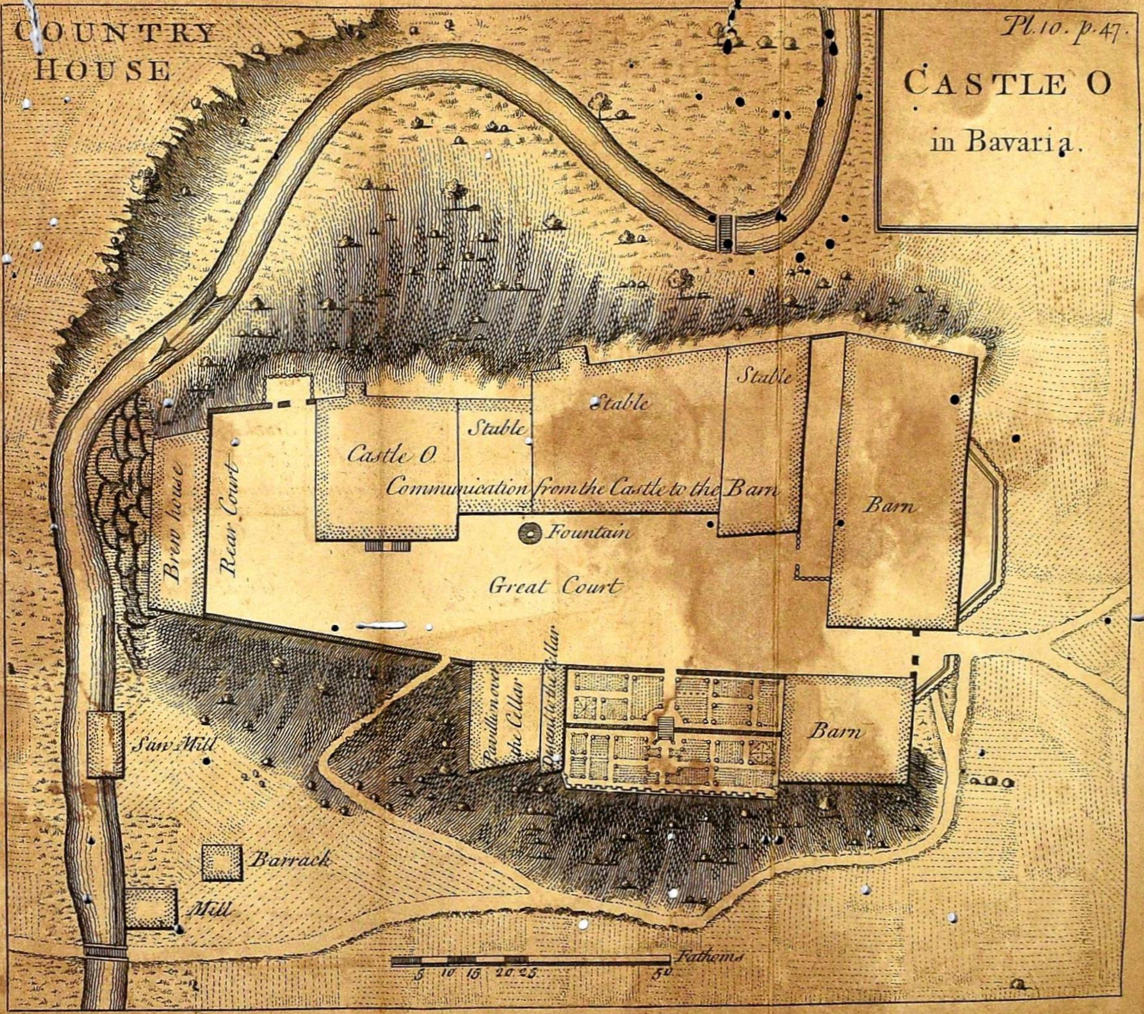

COUNTRY HOUSE
Pl. 10. p. 47.
CASTLE O in Bavaria.
Stable
Stable
Stable
Castle O
Communication from the Castle to the Barn
Brew house
Rear Court
Fountain
Great Court
Barn
Pavilion over the Cellar
Descent to the Cellar
Barn
Saw Mill
Barrack
Mill
Fathoms
5 10 15 20 25 50

ties to defeat all ſchemes of the enemy; which being done with ſucceſs, often reduces a ſuperior enemy to an equality before the end of a campaign.

It is therefore required to make uſe of country-houſes, church-yards, or villages, in caſe of being overtaken by a ſuperior party of the enemy, and to barricade or fortify them by ſome ſmall work or other, in order to gain time, either for being ſuccoured, or eſcaping in the dark. All this the author has endeavoured to explain by ſuch examples in which he was chiefly concerned, in ſo clear and inſtructive a manner, as requires very little elſe to be ſaid on the ſubject. I ſhall only obſerve, that in the example cited of M. *Saxe*, when he defended a houſe with 18 men againſt 200 dragoons and 600 horſe; there is to be added, when it was dark he ſallied out of the houſe, his men having their bayonets fixed, with order not to fire, by which means he eſcaped and got into a wood, where he could not be purſued.

In the laſt war in *Flanders*, an enſign of ours was placed in a village, with a party of men, through which the *French* intended to paſs with a conſiderable detachment; it happened luckily that there was a young engineer with this party, who adviſed the enſign to have the principal ſtreet barricaded, and to throw up an intrenchment croſs the road at the entrance of the place; which being done, and men placed there; when the

French

French ſaw the good countenance of our troops, and their diſpoſition, went another way, imagining that there was a much greater force than appeared; and the enſign was rewarded with a company for his behaviour, though in reality the honour was due to the engineer, who adviſed him to this bold ſtep.

CHAPTER THE FOURTH.

I. *Fortifying ſmall towns and other conſiderable places.* II. *Advantages and diſadvantages in regard to the diſpoſition and conſtruction of the houſes.* III. *Inconvenience of their great extent.* IV. *Means of correcting it in certain caſes.* V. *Inconveniencies almoſt always inſurmountable.* VI. *Places to be intrenched for a day of battle.* VII. *Communications to be eſtabliſhed from a poſt to a bridge; firſt example.* VIII. *Second example.*

I. VARIOUS circumſtances, ſuch as the neceſſity of keeping an enemy at a diſtance, preſerving communications, ſecuring from ſurprize a body of troops in winter quarters, or quarters of refreſhment, often oblige to fortify larger places, than thoſe already mentioned.

An engineer muſt, in this caſe, carefully examine the ſituation of the place, the nature of its environs, the diſpoſition and conſtruction

ſtruction of the buildings, the extent of their circuit, what troops it can contain, that is to ſay, what number can be encamped or quartered in it, according to the ſeaſon.

He muſt examine at what diſtance the neareſt woods are; if the roads are good or bad; the number and kinds of workmen and tools, and the number of carts and beaſts to draw them, on which he can depend; in fine, what aſſiſtance he can procure in the place itſelf, and what are near at hand.

Theſe attentions are all equally indiſpenſable; a village, and even towns commanded by eminences, ſuch as *Donavert* and *Deckendorf*, are always very bad poſts. A precipice at all times, and, except in great froſts, a river with ſteep banks, a place that can be laid under water, a deep moraſs, a low ground and full of ditches, are always advantages, if they are at a convenient diſtance from any part of the intrenchments: ſo much of the intended work is thus leſſened, and a very eſſential point gained; for on theſe occaſions, there is ſeldom any other workmen than thoſe to be had from the troops, deſigned to guard the place, and their number is commonly regulated by what it can contain.

When a place is intirely ſurrounded with an intrenchment, a ſingle ditch, if it is not deep and full of water, is ſeldom ſufficient to ſtop an enemy: it is therefore uſeful, and often neceſſary, to palliſade and fraiſe; beſides, there muſt be bridges and barriers

which

which require wood, carriages, workmen and tools.

II. How important ſoever ſuch aſſiſtance may be, one is ſometimes obliged to do without it: one may in part ſupply it, by the means I ſhall ſpeak of in treating of the conſtruction.

There are places ſo advantageouſly ſituated, that they ſeem intended to be intrenched: ſuch are thoſe on the brow of a ſteep hill, or which occupying the bend, or conflux of rivers not fordable, are naturally inacceſſible for the greateſt part of their extent.

On the contrary there are ſome, which, on account of defects not to be remedied, ought abſolutely to be rejected, as incapable of any defence; ſuch among others, are thoſe which are commanded by adjacent heights, from which the parts liable to be attacked cannot be covered: this maxim, though truly evident in itſelf, yet regard muſt be had to circumſtances attending it: the part commanded, for example, may be inacceſſible, and on the ſide expoſed to the attac, covered by houſes; in that caſe, ſuch a place may be defended, ſince ſome little poſts are ſufficient in thoſe places that are commanded; which may eaſily be ſheltered and ſecured from danger, and preſerve their communication by ſome adjacent building.

It was thus I propoſed to eſtabliſh a poſt in the church-yard, of the ſuburbs of *Deckendorf*, ſituated at the foot of a hill, almoſt perpendicular,

perpendicular, but partly covered by the church: the intent was only to contribute to the preſervation of a communication from the ſuburbs to the town, and from the town to the *Danube.*

III. A village ſituated in dry and even ground, ſuch as affords no advantage, is ſeldom proper for the uſe we are ſpeaking of.

What is here eſteemed a great defect, is, generally ſpeaking, a circumſtance to be deſired in fortified places; but though the rules of fortification may hold good in both caſes, yet they are very different: in one, we work at leiſure, and with all things neceſſary; in the other, the time and means are limited.

There is a neceſſity, therefore, of drawing from the ſituation ſuch aſſiſtance as may abridge the work; it is, as I have ſhewn, of various kinds; the diſpoſition and conſtruction of the buildings, ſometimes furniſhes the ſame advantage as a good ſituation.

When I arrived at *Donaſtauf*, in *September*, 1742, I found ſome officers of the two battalions quartered there, employed in intrenching that town. The caſtle, from which no other aſſiſtance could be expected, for want of loop-holes and ſcaffolding, covered part of it by its height: a hill of great extent, incloſed by a wall, and the contiguous houſes, greatly ſhortened the work. I was otherwiſe employed, and had only one engineer with me: I adviſed them, and they ſucceeded ſo well, that in a few days, having received

received advice that the enemy ſeemed diſpoſed to attack them, they found themſelves in a good poſture of defence.

When the houſes, though ſeparated from one another in many places, do not form a very long figure, and as in large towns, are built and covered ſo as not to fear fire, they may be uſeful, by making loop-holes in them, and in the intervals throwing up ſome intrenchments, that may flank each other, or be flanked by thoſe buildings which project pretty far; it was thus I propoſed for one part of the ſuburbs of *Deckendorf*.

But if the houſes are of wood, as in *Bavaria* and *Bohemia*, or of earth and thatched as in *Flanders*, they are only fit for habitations, and are otherwiſe more dangerous than uſeful.

IV. The greatneſs of the circuit, adds to this inconveniency, and in regard to circumſtances, ſometimes forms an inſurmountable one. I found myſelf in this caſe at *Pilſting*, a town ſituated on this ſide the *Iſer*, half a league from *Landau*. Its poſition made it propoſed to quarter ſome troops there, and was reſolved upon, as ſoon as it was known that the *Auſtrians* had taken poſſeſſion of it.

I was ſent from the army the 14th of *November*, that is, two days after the ſurrender, and having received orders to intrench the town, I carefully examined it, and quickly diſcovered moſt of the defects I have mention-
Plate XI. ed; it is not commanded on any ſide, its en-
virons

virons are alſo croſs cut with ditches and drains, and almoſt throughout marſhy: but the winter approached, and is very long and ſevere in *Bavaria*; therefore theſe advantages of nature, that ceaſed on the firſt froſts could not be relied on: beſides, of 70 houſes which were in *Pilſting*, 7 only were of maſonry, and the reſt of wood.

We were conſequently under a neceſſity of intrenching it entirely, or at leaſt to fortify its bounds by ſuch works as we ſhall treat of, which was not even practicable.

This new difficulty proceeded from the houſes being moſtly ſeparated from each other by yards and gardens; their circumference, tho' they formed four different ſtreets, could not be reduced to leſs than 850 fathoms.

I perceived that this place would only quarter one battalion, which was neither ſufficient to fortify or defend it.

This reaſon alone was unanſwerable; but I ſhould likewiſe have had great difficulty to get as many paliſades as neceſſary; the *Rindal*, a little wood, one league off, towards *Straubing*, being entirely cut down, we ſhould have been obliged to fetch them farther off, and the few horſes and oxen, which the *Auſtrians* had left, were not ſufficient, eſpecially with bad carriages and worſe roads.

Tho' the church-yard was ſpacious, and encloſed with a good wall, and it was eaſy to make a communication with three houſes of ſtone, and two of wood, which joined it, the

the enemy not being able to get thro' thoſe of wood ſoon enough, if they did ſet fire to them, not to leave us ſufficient time to ſupport, or at leaſt to barricade the opening they ſhould make; and as this particular poſt, good only for a laſt reſort, decided nothing in our favour, as we could not make uſe of it without abandoning the town, the ſick, the ſtores, and the baggage, I did not heſitate to conclude, that *Pilſting* was incapable of being entirely fortified.

V. There are circumſtances, which oblige to ſacrifice the intereſts of private people for the publick good: there are even cruel wars, where the neceſſity of the repriſal forces in ſome meaſure the devaſtation which it authoriſes; very terrible circumſtances, and which an engineer ſhould never practiſe without particular orders, and which he ſhould very ſeldom demand.

It is plain, I would ſpeak of thoſe occaſions where the uſeleſs parts are deſtroyed, to preſerve with much leſs work thoſe that are uſeful. Had we been in this caſe at *Pilſting*, and that part of the town moſt compact together had been ſufficient for our purpoſe, all would have been eaſy, at leaſt very poſſible.

By levelling the houſes, which extended along the roads of *Straubing* and *Deckendorf*, the circuit would be ſhortened more than 200 fathoms, that is, about a fourth, and very little quarters would have been loſt.

That

That was a great deal, yet inclosing the remainder, seemed too considerable a work for one battalion, weak as they always are at the end of a campaign, and pushed perhaps, by the unexpected march of the neighbouring troops, to hasten the intrenchment: I believe that on these occasions we may have recourse to the expedient I shall here propose.

Having determined the figure of the inclosure in the most convenient manner, raise at the angles redouts in the form of Bastions, whose fire crossing in the intervals, reciprocally graze the faces of these little works.

The Plan will explain my design: five sides of the exterior polygon are of 100 fathoms each: they may be of 120, or even 130. The perpendicular is one twelfth of the side; the faces are 12 fathoms, and the flanks perpendicular to the lines of defence. Plate XI.

The sixth front is near 150 fathoms, but it is better defended, as the faces are grazed by the wall of the Church-yard, and the two parts of this wall, the most projected, are also grazed by the flanks of the adjacent Bastions.

This figure is no more than a Polygon fortified after the common method, excepting, that there are no curtains. The *Redans* would have been of more extent than these redouts, which are substituted in their room; I therefore save all the curtains, that is to say, more than 420 fathoms of work; for reckon-

reckoning 50 fathoms for each redout, the 720 fathoms, which were to have been made, are reduced to 300.

As to the defence, 50 men in each redout, as many in the church-yard, and the reſt of the battalion drawn up with the grenadiers, in the propereſt place to ſupport where neceſſary, are ſufficient.

I don't know that this ſcheme was ever executed, or even propoſed: yet it is ſo plain, that I cannot think it new; whether it is, or is not, it may be uſeful in certain Caſes.

Having given an account of its advantages, it is but right to expoſe its defects: in a quarter not incloſed, ſuch as this, the ſoldiers may ſtraggle in the night, the peaſants may have dangerous communications, and a reſolute body may puſh thro' the intervals.

It is the commandant, or the engineeer, charged with the project, that ſhould examine if he can do better, in regard to time, and the number of Workmen: in this manner a poſt is quickly put into a ſtate of defence, which, according to the common method, cannot be done but with a vaſt body of men: this advantage is a real one; beſides, if we have time, or ſhould haſten a little more, nothing prevents our perfecting the encloſure with a parapet of earth, or by trees, or any other kind of barricades.

VI. Whatever number or variety of expedients experience and imagination may ſuggeſt,

geſt, yet places are ſometimes found in a plain, as at the foot of mountains, which we can turn to no advantage.

The greateſt part of villages are thus ſituated; the houſes commonly extend along one or two roads that run through them, the reſt is only courts, orchards, and gardens, encloſed with very bad hedges, narrow ditches, walls of mud, dry ſtone, or wood, which renders the circuit exceeding great, in proportion to the number of houſes: ſuch is *Schleitel* on this ſide the *Loutre*, only compoſed of two rows of houſes in right lines, and ſeparated from each other; and is at leaſt as long as *Straſburg*, including the citadel.

When houſes are built, or covered with combuſtible matters, it is, as I have already ſaid, another inconveniency: I found them all united at *Biſchoffmais*, a village, three quarters of a league this ſide O caſtle; and deſigned alſo for a magazine of forage. The church-yard, the ordinary reſort in like caſes, could not defend the barns, becauſe of its diſtance; beſides, being narrow, and ſurrounded almoſt every where with houſes of wood, which commanded it, I ſaw that the enemy had it in his choice, either to fire on, or burn thoſe that defended it.

I examined the village, according to my orders; but I propoſed nothing for its defence, becauſe it appeared impoſſible to me to do any thing: ſo that the lieutenant which

 was

was left there with 30 men, owed his ſafety, and that of his men to his own ſkill.

During the attac of the caſtle, ſome men having appeared to reconnoitre it, he took the only advantage to be taken, which was to retire into the church, barricaded its avenues, and made loop-holes with ſcaffolding, the uſe of which I had ſhewn him: chance favoured his precautions, and ſaved the magazine; twenty volunteers who were eſcorting a ſmall convoy of bread, going to *M. de Graſſin* on the frontiers of *Bohemia*, finding the roads ſtopped up, joined themſelves to him; they had two drummers with them, which the officer made good uſe of; for at the uſual hour of beating the retreat, he ordered them to beat that of the infantry and dragoons at the ſame time, and it was this ſtratagem, perhaps, that made them poſtpone attacking this, till after the taking of the principal poſt, which as I have ſhewn, could not be forced.

VII. Thus the greateſt difficulties to be ſurmounted in fortifying ſmall towns and villages, are the diſadvantages of a commanded ſituation, of an incloſure of great extent, and the dangerous conſtruction of the houſes, which will not permit to uſe them in the defence.

We have hitherto ſuppoſed the moſt ordinary caſes, that is, a detached poſt or quarters to be ſecured; but there are others, where different circumſtances oblige us to

be

be regulated by other maxims. Such for example, is the fortification of a village, intended to be of service in a day of battle: whether it be advanced, or in the line itself, or on one of the wings, it signifies little, and is often more useful than hurtful, that it be commanded, provided it be only in the rear.

The number of troops to be employed in it, not depending on what the place can quarter, the inconveniency of its great extent, and even of the combustible materials employed in its construction disappear; as the principal use of the houses is to hide any necessary motions from the enemies sight, all that may be hurtful must be inclosed, not regarding the number of workmen and troops such works require.

What is most essential, and particularly to be regarded, in this case, is in my opinion, to have as large flanks as possible, because there is not the stratagems or feint attacks, but the effort of a column to be resisted; to lay open the environs, by cutting down all trees, hedges, &c. within two feet of the ground, that the artillery may have the greatest effect possible, which is here absolutely necessary; to incumber the ground before it, and on its flanks, that the enemy may not advance without being broke; and to level all in the rear, that the troops may return to the post with force, and in

in good order, in caſe neceſſity ſhould require it.

When the village terminates the line, the intrenchment muſt be lengthened by a return gibbet-wiſe, and the expoſed ſide incumbered, to guard the better againſt being flanked by the enemy.

A favourable ſituation, eſpecially, if it juſt riſes ſo as to command the parts to be battered, is always a great advantage: many circumſtances, which in other caſes are conſiderable obſtacles, are not here to be regarded and vaniſh by the means we have of ſupplying their defects.

This article is more eſſential to an engineer than is commonly imagined: few battles have been fought without ſuch poſts, and that of *Fontenoy* is an example of what importance they may be.

VIII. When the town or village is advanced before the army, and at ſome diſtance from a river, and conſequently from a bridge, the town muſt not only be fortified, but the paſſage to the bridge muſt likewiſe be well ſecured, that ſo eſſential a communication, as well for ſuccours as a retreat, may not be cut off.

I was twice intruſted with this charge in *Bavaria*; *M. de Balincour*, poſſeſſing the riſings which commanded the openings of *Dingelſling* beyond the *Iſer*, the enemy being maſters of *Landau* only ſix days, abandoned it;

it; I received orders to put that place into a ſtate of defence as ſoon as poſſible.

It is ſituated on the brow of a little hill, of which it occupies the whole breadth up to the top: two gates, one below, another above, divide the ſurrounding wall, almoſt into two equal parts: on the right of the entrance of that ſide, next the river, the wall is low, and no more than two feet broad, it almoſt every where joins the houſes; but it is not commanded, and the ground on which it is built is ſo ſteep, as to be impracticable to paſs it. I obſerved that the floors of the houſes might ſerve for banquets to the loop-holes, and that it was eaſy to build wooden ones in the courts, yards, and ſuch like places I found round the wall.

On the left, the wall appeared in better condition, except in one part, where it was propped up, and conſequently muſt be intrenched; it was between 4 and 5 feet thick, a little roof, which covered the wall in places where the houſes did not touch, was a protection from the riſing grounds, and there needed only ſome ſlight repairs, and to break through ſome houſes, to have a communication from one gate to another: this ſide has a broad and deep ditch with a ſteep ſlope.

There were breaſt-works and folding-gates, with their barriers at the two gates. The incloſure, ſpeaking in general, had neither towers, nor flanks; but I found they might ſoon be made, and at little expence, by a

method I ſhall ſpeak of in treating of the conſtruction; ſo that by this aſſiſtance, abſolutely neceſſary againſt ſcaling and ſapping, I flattered myſelf, I ſhould in a few days put the body of the place into ſuch a ſtate of defence as not to be forced without cannon.

The ſuburb is almoſt of as great extent as the town; I could not avoid preſerving them, as well for the neceſſity of quarters at that ſeaſon of the year, as to incloſe the ſpot where a bridge was to be built, in the room of that burnt by the enemy. This ſuburb was commanded by a conſiderable riſing very near, reſembling a truncated cone, on the top of which was a large chapel. I propoſed to poſſeſs theſe eminences by redouts, which ſhould communicate with the ditch of the place, and to raiſe ſome others at proper diſtances, in the flats of the *Iſer*, to be joined together by a little parapet, ſurrounded by a wet ditch. Theſe precautions were ſufficient on this ſide; on the other, a ſimple intrenchment, well palliſaded, would incloſe the ſhort ſpace between the ſteep hill and the river. This is ſufficient to ſhow what may be done on like occaſions; it would have been the work of a very few days, but I had not time even to begin it.

IX. While the greateſt part of our troops were forming on the other ſide the *Iſer*, *M. Saxe* driving all before him that attempted by favour of the defiles, to oppoſe him in his march, advanced on the other ſide the *Danube*; it was reſolved to return to *Decken-*

dorf.

dorf. *M. le Comte d' Aumel,* commanding in chief the engineers, ordered me, when I leaſt expected it, to join him; which I did the ſame day, returning by *Straubing* to *Ober-Alteich*, the general rendezvous, and from thence to *Pogen*, our particular quarter.

Our little army, which we then called the reſerve, chearfully embarked the 2d of *December*, on the *Danube*; (except the cavalry who took the common road) and though often cloſely purſued by the huſſars, who drew up in order within piſtol-ſhot of the river-ſide, arrived at *Deckendorf*, a little below the ruins of the bridge we had burnt three months before, when we marched for *Bohemia*.

The enemy ſurprized, at our ſudden arrival, and by that rout, abandoned the place after ſome diſcharges of cannon; ſo that inſtead of being employed in ſecond, at the ſiege, according to my firſt deſtination, I was to put this place into the beſt ſtate of defence.

This would have been an eaſy matter, was it not for the heights, which rather plunged into it, than commanded it: it was ſufficient to repair the banquets of the body of the place, to renew the platforms in the towers; and in caſe of an attac, when the ſpot was once determined on, to raiſe on the right and left, from the principal wall, to that of the *Fauſsbray* intrenchments, with palliſades joined, and with loop-holes, and ready prepared, which would flank the troops with a croſs fire,

fire, who ſhould endeavour to force a breach, and which we in the mean time would have intrenched and barricaded within.

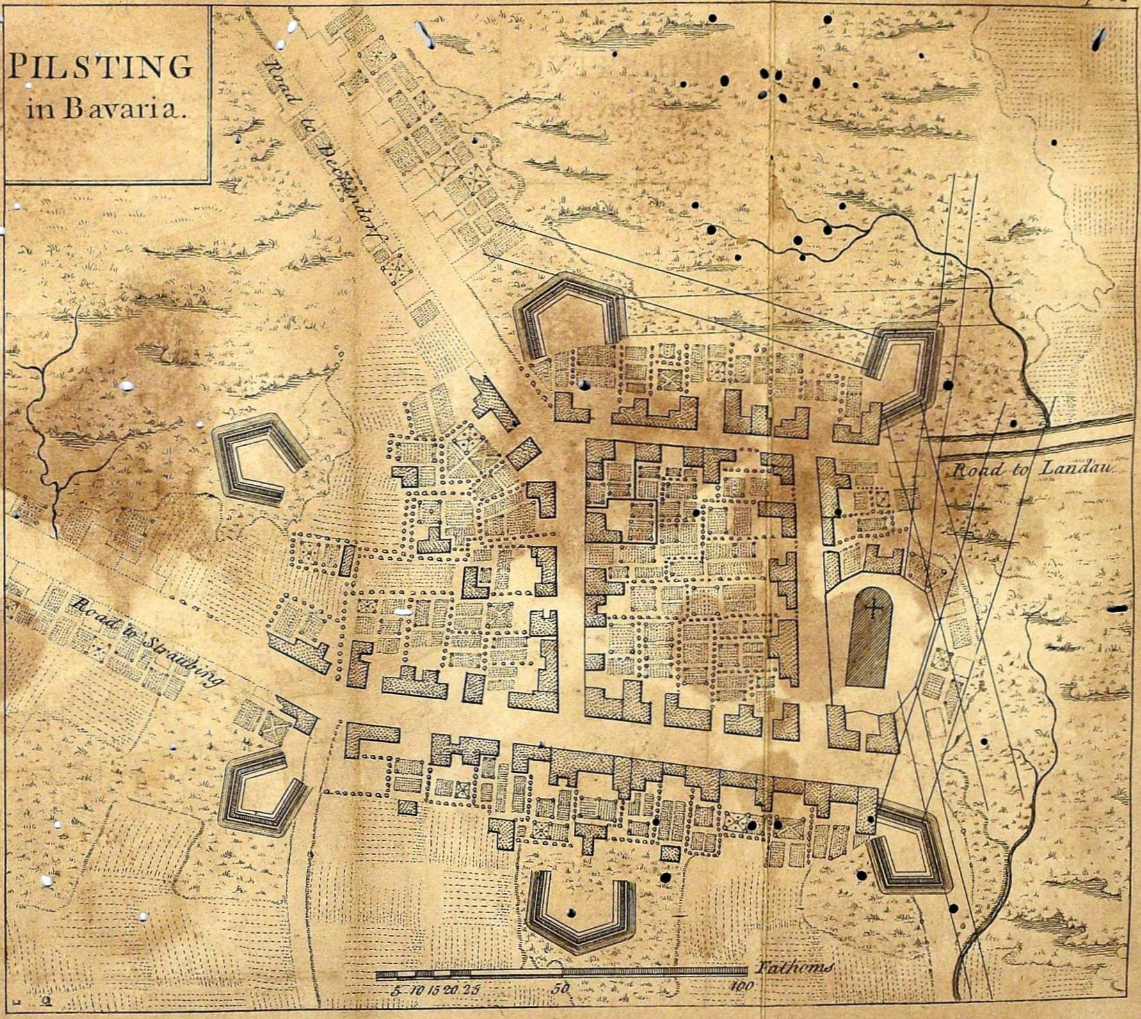
As to the principal ſuburb, the proximity of the *paung*, and of the hill, otherwiſe ſo diſadvantageous, the ſituation of the church-yard, the great extent of the court of the parſon's houſe, and the incloſure of the capucins, were very favourable circumſtances.

Plate XII. I was charged with the town and the plain, that is to ſay, to repair the body of the place, to intrench the ſuburb, and to preſerve a communication with the *Danube*. The plan will ſave me a tedious detail; I ſhall therefore confine myſelf to ſome notes on it, where it requires an explanation.

The intrenchment A at the head of the ſuburb was begun; it was covered by a redout, which could not be taken without being maſters of two others, and it preſented a much greater fire on the defile than could be oppoſed to it; though good againſt a ſurprize, it would be difficult to be maintained in a general attac, becauſe of the heights.

The church-yard B is a terraſs, raiſed 18 feet, and lined with a parapet of good maſonry, with large loop-holes: the church, and two rows of large palliſades, would have covered the party poſſeſſed of it, from the fire of the hill, though almoſt perpendicular: the little intrenchment C which flanks it, covered an old bridge, and incloſed a conſiderable number of houſes.

The


PILSTING
in Bavaria.
Road to Deckendorf
Road to Landau
Road to Straubing
Fathoms
5 10 15 20 25 50 100

The intrenchment D (propoſed to ſupply this, in caſe the incloſure was found too extenſive, or the troops too much diſperſed in the different poſts) and that of F are deſigned to cover a communication, open from the place to the *paung*, as well by the gate of *Nider-Alteich*, as by the poſtern E, which I deſigned to make, when repairing part of the wall that was fallen down: dams were alſo to be made, to fill the river to the ſummit of its banks, that it might not be forded.

The direction of the works, which extend from the *paung* to the *Danube*, ſhew that it is a crown-work, without curtains, where the left redan of the head of the bridge, forms a demi-baſtion.

The front was to have been defended by batteries placed on the other ſide of the *Danube*: the fire of the baſtion on the right, covers the gate of *Straubing*, and the little work at the ovens ſerved to keep the *Saiques* in awe, which might endeavour to get up again.

Suppoſing *Deckendorf* in a plain, it could not have been put into a ſtate of defence, and the communications preſerved, with fewer works; but *Deckendorf* and that part of the ſhore were commanded; theſe heights ought of neceſſity to be occupied, and ſo as not to be diſlodged; but this was not only very difficult, but almoſt impoſſible in regard to circumſtances; yet we endeavoured it, becauſe it was an indiſpenſable point.

M. le

M. le Compte d' Aumale himſelf, traced the three redouts marked in the plan; they could not be better diſpoſed; but theſe poſts neceſſarily required a number of troops to poſſeſs and ſupport them, therefore he depended only on the ſtate regiments are in, at the end of a long and laborious campaign, and our cantonment was ſufficient to furniſh the whole; but though the common time of ſickneſs was paſſed, thoſe that remained in health, ſix weeks afterwards, that is, at the end of *January*, were hardly ſufficient to guard the colours, much leſs to maintain themſelves in a poſt ſo diſadvantageouſly ſituated; on which account, and the hardneſs of the earth, cauſed by an exceſſive froſt, we had only traced one part of the works, and even that, far from being perfected, was no more than begun.

We ſhall conclude this chapter, by obſerving, that the preceding examples, not only ſhew the manner of making uſe of old incloſures, to retrench ſuburbs, making bridge heads, and to ſecure communications; but likewiſe that an engineer, how diſagreeable it may be to be imployed in ſituations where art cannot rectify nature, ſhould endeavour, without being diſcouraged, to leſſen the evil which he cannot intirely remove.

Observations on the fourth Chapter.

The author treats here the manner of intrenching poſts of a great extent, either to contain

contain a conſiderable part of an army, during the ſummer ſeaſon, or for winter quarters; or ſometimes to ſecure a large magazine of forage, or the heavy baggage of an army.

A poſt, ſurrounded partly by a river, and partly by impaſſable marſhes, may be eaſily intrenched, and defended with a ſmall number of men, during the ſummer ſeaſon, but cannot be maintained in winter; becauſe, the froſt would render the paſſage over the river or marſhes as eaſy as dry ground: it requires therefore, different conditions to fortify a poſt in ſummer, from thoſe of one in winter.

The moſt important attention of a general ought to be, that of ſecuring his magazines of forage and proviſions, in ſuch a manner, that the enemy may not be able to deſtroy them, either by ſurprize or by open force: they ought to be as near the army as can conveniently be done, that the convoys may not require too great a party of men; which would fatigue the troops too much; all wood and defiles between the magazines and the army are to be carefully avoided: and in caſe the army is obliged to move farther off, either to retreat before a ſuperior enemy, or to purſue; the magazines muſt move alſo, or new ones are to be formed. I am perſuaded, whoever conſiders attentively, the importance of theſe precepts, will agree, that this part of generalſhip is one of the moſt eſſential, in the carrying on a ſucceſsful campaign:

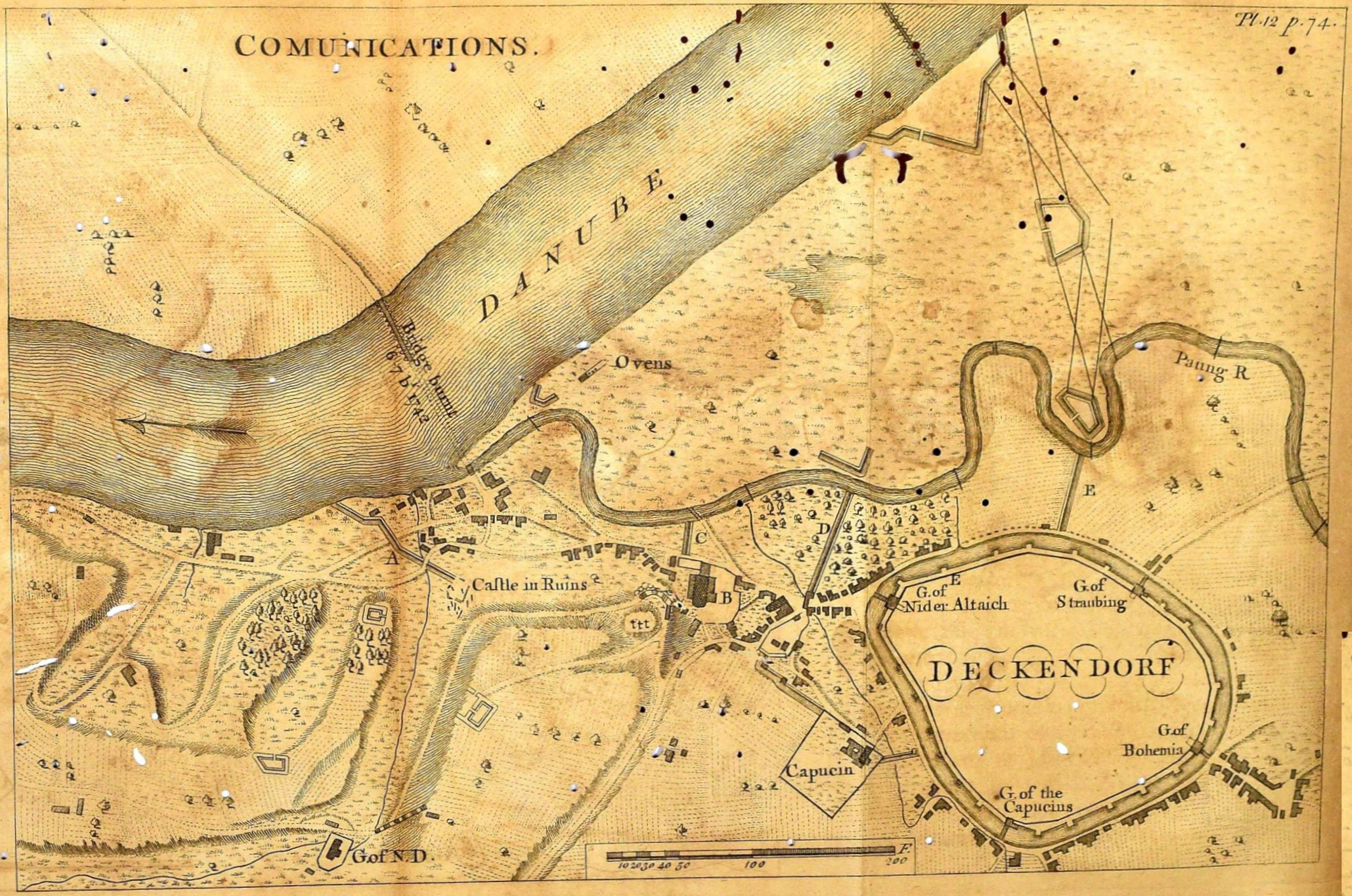
paign: many examples might be given, that have happened in this preſent war, where theſe precepts were not ſo well regarded in all appearance as they ſhould have been, both by us and our enemies: but as our deſign is only to inform the reader of what ſhould be done, and not what has been done, we ſhall proceed no farther.

CHAPTER THE FIFTH.

I. *Intrenched camps; their uſe.* II. *Their poſition:* III. *Encampment of troops.* IV. *Intrenched camp of* Ruſſenheim; *firſt ſcheme.* V. *Second ſcheme, with reflections.* VI. *Enquiry into the interior of the firſt.* VII. *Third ſcheme.* VIII. *Defects of the firſt and third.* IX. *Intrenched camp of* Spire.

I. WHEN there are reaſons for keeping a large body of troops together, their camp is intrenched for a greater ſecurity.

The *Greeks*, the *Romans*, and moſt other nations, ſeldom made any ſtay in a place, without fortifying themſelves in it. The army being aſſembled, forms by its poſition a ſquare, or ſome other rectangular figure of ſmall circumference, in regard to the number; this cuſtom ſeems to have been practiſed, till the laſt century; but that of encamping in one or two lines being ſince introduced, cannot be intrenched otherwiſe than by lines; but



Pl.12 p.74.
COMUNICATIONS.
DANUBE
Bridge burnt 6 7br 1742
Ovens
Paung R
A
B
C
D
E
Castle in Ruins
G.of Nider Altaich
G.of Straubing
DECKENDORF
G.of Bohemia
Capucin
G. of the Capucins
G.of N.D.
F
10 20 30 40 50 100 200

but it is neither of these lines, or of these transitory camps, that we shall treat of here.

These camps are of a more modern invention; I do not know even, if we are not obliged to *Vauban* for them. They were formed in his time at *Namur*, *Ath*, *Lauterbourg*, and *Dunkirk*; and this general, so good a judge of this matter, ventures to say in one of his best works (*a*), that he wished they were made beforehand at all the frontier places.

The principal objects he proposes by this, is to put it out of the enemy's power to besiege the place, or at least to expose them to the danger of not succeeding.

If the use of these camps was confined to that alone, it is only in a treatise of defence of places, where it should be mentioned, and there could be but little more added on that subject, than what that celebrated engineer has given us; but however essential they may be in that case, they are not less useful in others, which fall under that kind of war which is here mentioned.

Lauterbourg, for example, with regard to its fortification, and above all to its position with the lines of the *Loutre*, ought rather to be considered as a post, than as an ordinary place, and with the assistance of intrenchments, it becomes in some manner unattackable.

(*a*) *Traite de la* Defence *des places.*

A town

A town, ſuch as *Spire*, ſurrounded with a bad wall, without a rampart, is in itſelf incapable of ſupporting a ſiege; but intrenchments being added, are ſufficient to deter an enemy from attacking it.

The advantages of theſe camps extend yet further: an army never expoſes its flanks to a conſiderable body of troops without danger, when this body by its extent cannot eaſily be kept in awe; even ſimple detachments do not make excurſions with impunity, when their paſſage, and above all their retreat, is made ſo dangerous.

Lauterbourg and *Spire* can by this means, if neceſſary, cover the country on this ſide the rivers which run through them.

Laſtly, Mr. *Vauban* obſerves, that intrenched camps ſerve likewiſe to place magazines, all kinds of ſtores and baggage, and to ſecure the adjacent country people, with their families, their effects and cattle.

II. No intrenched camp has hitherto been made but under ſome place, good or bad; which ſerves it for a retreat, or ſupport, as neceſſity requires, and likewiſe has all neceſſary ſuccours at hand; a very eſſential circumſtance.

It is ſeldom that the ground adjacent to a place does not furniſh ſome favourable ſituation: the antient intrenched camp of *Dunkirk*, ſituated in a plain, was covered on one ſide by the canal of *Bourbourg*, on the other by the Canal of *Moure*, and the front defended

fended by *Fort Louis*. That of *Lauterbourg*, inacceſſible in the rear, was on the ſide of a riſing ground, at the foot of which the *Loutre* dividing into two branches, runs thro' a flat and marſhy meadow.

Such convenient places are not found every where, but it is the engineer's buſineſs to ſeek for them, and to ſeize on all advantages. It muſt be obſerved, that theſe intrenchments being much leſs extended, and conſtructed more at leiſure than lines, they are made much ſtronger; they are turfed, palliſaded, and more time and care is ſpent in fortifying them; by this means indeed there is therefore ſcarce any ground but what may be put into a good ſtate of defence: thoſe that are ſo commanded, that a motion cannot be made without being perceived, and where the parapets on that account do not afford ſufficient cover, muſt generally be excepted. Low, marſhy, unhealthful places, and where there may be a ſcarcity of water, ought equally to be rejected.

III. When the ground permits, the Figure of the camp ſhould neither be triangular, nor long, but ſuch, as that its ſuperficies may be the largeſt poſſible, in proportion to its circumference. Of all rectangular figures, the ſquare contains more ground in proportion to its boundary than any other, and thoſe which come neareſt to it contain more than others.

The circumference is regulated by the number of troops destined to occupy the post, or when it cannot be avoided, the number is regulated by what the Place can contain.

In either case, it is necessary to know what space must be allowed for the encampment and motions, and this cannot be known without entering into some detail; as well because of the difference of the number of men in the companies and troops that compose the battalions and squadrons, as the variations common in this case.

The front of the camp must be parallel to the intrenchment, and if possible 50 fathoms distant from it at least, that the Troops may be drawn up in order of battle, and perform their necessary evolutions.

A foot soldier's tent is 6 feet square, exclusive of the boot: 7 soldiers, or 5 soldiers and one serjeant, are allowed to a tent: the first and last face the front and rear of the camp, the rest are parallel to the front.

A company strong or weak always encamps in file, and consequently has but one tent in front. The files or companies are backed two by two, leaving an interval of a little street for the boots.

M. Bombelle gives 6 paces or 3 fathoms in front for the 2 files of Tents. *M. Haricourt* allows only 5 paces, which is as little as possible, the little street for the boots being thus only 3 feet.

Between

Between every 2 companies there is a great ſtreet of 16 paces, according to one of theſe officers, and only 6 according to the other; a like ſtreet ſeparates the grenadiers from the battalion, whoſe tents are not backed by any others.

The front of a battalion is thus equal to 90 paces, or 45 fathoms; becauſe the battalions conſiſt of 9 companies, inſtead of 17, when *M. Bombelle* wrote; which ſhews that in encamping regard muſt be had to the ground that the troops take up when drawn up in order of battle.

As to the depth, *Bombelle* allows 32 paces for 11 tents, and *Haricourt* 17 for 6, which is much the ſame, ſince there is always one pace between each, without regarding the boot of the firſt and laſt.

From the laſt tent of the ſoldiers the reſt are placed as follows; to the kitchens is allowed 10 paces; to the drummers and ſutlers 20; to the ſubalterns 35; to the captains 45; and to the field officers 80.

A *French* battalion therefore on its preſent eſtabliſhment takes up for its camp 45 fathoms in front, and 48 fathoms 3 feet in depth, reckoning from the head of the tents; it is clear that nothing can be deducted from the firſt of theſe dimenſions; but in the caſe we are ſpeaking of, the three field officers are commonly in lodgings, and the other diſtances may be diminiſhed; I do not ſee the

 leaſt

leaſt inconveniency to reduce the depth to 30 fathoms.

The interval of one battalion from another is commonly 10 fathoms, and there cannot well be leſs. The ſecond line is commonly 100 or 200 fathoms from the firſt unleſs in certain caſes, ſuch as an intrenched camp, where 40 or 50 fathoms are ſufficient.

The cavalry are commonly placed in the ſecond line; each troop, like the infantry, has but one file of tents, and like them, two troops are back'd to each other. Seven paces are allowed for two of theſe back'd files, including the little ſtreet; three paces from the front of the tents to the piquets for the horſes, which face the tents, and 12 or 15 paces from one range of piquets to another, ſo that the horſes may have a ſtreet ſufficiently wide between.

The camp of a ſquadron of 4 troops takes up 50 or 56 paces in front, and its depth is determined according to the number of men, allowing 7 men to a tent, and 7 paces from the pole of one tent to the next, including the quarter maſters; ſo that every horſe may have 3 feet in breadth.

At fifteen paces from the piquets are the kitchens and forges; at 25 the Sutlers; at 45 the ſubalterns; at 65 the captains, and 30 paces farther the field officers.

There is no interval between the ſquadrons of the ſame regiment. *M. Haricourt* allows 10 paces from one regiment to the next, 30 between

between the brigades, and 40 between the cavalry and infantry.

I do not mention the bells of arms, nor ſtandards, tho' it is from thence we commonly reckon the front of the line; nor the quarter guards and neceſſary houſes, becauſe this detail is not eſſential to the ſubject in hand. However, it is right to conſult all theſe things with the quarter-maſter-general, or to take the orders directly from the general.

IV. I ſaid we never had an intrenched camp but near ſome town or fortreſs; I ſhould indeed have excepted the following caſe.

The 11th of *May* 1734, I was ſent from the army at *Bruchſal*, to *Ruſſenheim*, a village one league above *Philipſbourg*. I there found the brigades of *Gondrin* and *Britany*, each of 4 battalions, and the regiment of dragoons of *Languedoc*, under the command of *M. de Balincour*. This place, being intended to be made a poſt, could not contain ſo many troops; it was therefore neceſſary to fortify the camp, which was extremely eaſy, as the ſituation was very favourable.

The plan ſufficiently ſhews this: the ground to be occupied was higher on the flanks and rear than its environs. The right was covered by a quick hedge and bounded, as well as the village by the *Pſintz*, a little river with ſteep banks, where another arm and two rivulets fall into it. I obſerved grooves, and a free-ſtone flooring at the bridge, which Pla. XIII.

made it easy to form an inundation. Some banks could therefore easily confine the water, and raise it 8 or 10 feet from the foot of the village, to the place they empty themselves into the river: the meadows near the river were low and marshy. On the left a meadow commanded by a rising ground separated it from the *Rhine*, and the chapel being on a steep, higher ground than the rest, and covered with briars and bushes, served as a citadel.

Having by this only the front to intrench, and no want of workmen, I was resolved to spare no pains. In the evening I stopped the water to make the inundation; and after making my report to *M. de Balincour*, whose thoughts agreeing pretty well with mine, he ordered me to trace out the new camp the next day, in every respect, as in my sketch.

The fortification is very simple and plain; it is a kind of horn-work of 150 fathoms front, covered by a ravelin; the perpendicular is 20 fathoms, and the faces 40: the right branch runs parallel to a hedge which covers it; but the left, being of much greater extent, is flanked by returns at right angles, and by the chapel.

This line need not be very thick, as the returns only are exposed to cannon, because there is no probability that the enemy will engage in this confined place, where they are flanked besides by a considerable fire.

An

An engineer always works with pleaſure when he is thus ſeconded by nature, but I was ſoon deprived of this ſatisfaction. I had ſcarce marked out the camp, when *M. Portal*, who commanded us, arrived. He in general approved of my ſcheme; he would only have the head of the bridge ſecured by two redouts, and to make three redans, inſtead of the two half baſtions and to the ravelin; perhaps he had at that time deſigned the baſtioned lines, which we ſoon after traced before *Philipſbourg*; however he charged another engineer with the work, and took me the next day to viſit the lines on the *Loutre*, where I was in chief.

V. I do not know how this poſt was fortified, as I did not ſee it afterwards; but being confined to the figure, it was very difficult in other reſpects to conform to what was ordered.

We ſhall find in the enſuing chapter, that redans in themſelves have ſome eſſential defects, by the obliquity of their defences. Theſe defects, tho' known, do not prevent from uſing them to cover right lines and rentring angles; as to ſaliants, when they are right or acute, as the inconveniency increaſes in proportion to their acuteneſs, I do not know that the means of uſing them there has been found.

We commonly uſe ſmall baſtions, and in the caſe we are ſpeaking of, it being impoſſible

poſſible to make demi-redans, we ſubſtitute demi-baſtions.

From the point of one redan to the next is 120 fathoms, and the front was only 150. It was therefore neceſſary, in conformity to cuſtom, to return nearly to my ſcheme.

A redan may be placed inſtead of the ravelin, tracing the ditch parallel to the faces, to diminiſh the length of the faces of the half-baſtions, which, on account of the great extent of the front, I had left larger, to draw the fires nearer, and to change the direction of the flanks; but with all theſe alterations they are nevertheleſs demi-baſtions.

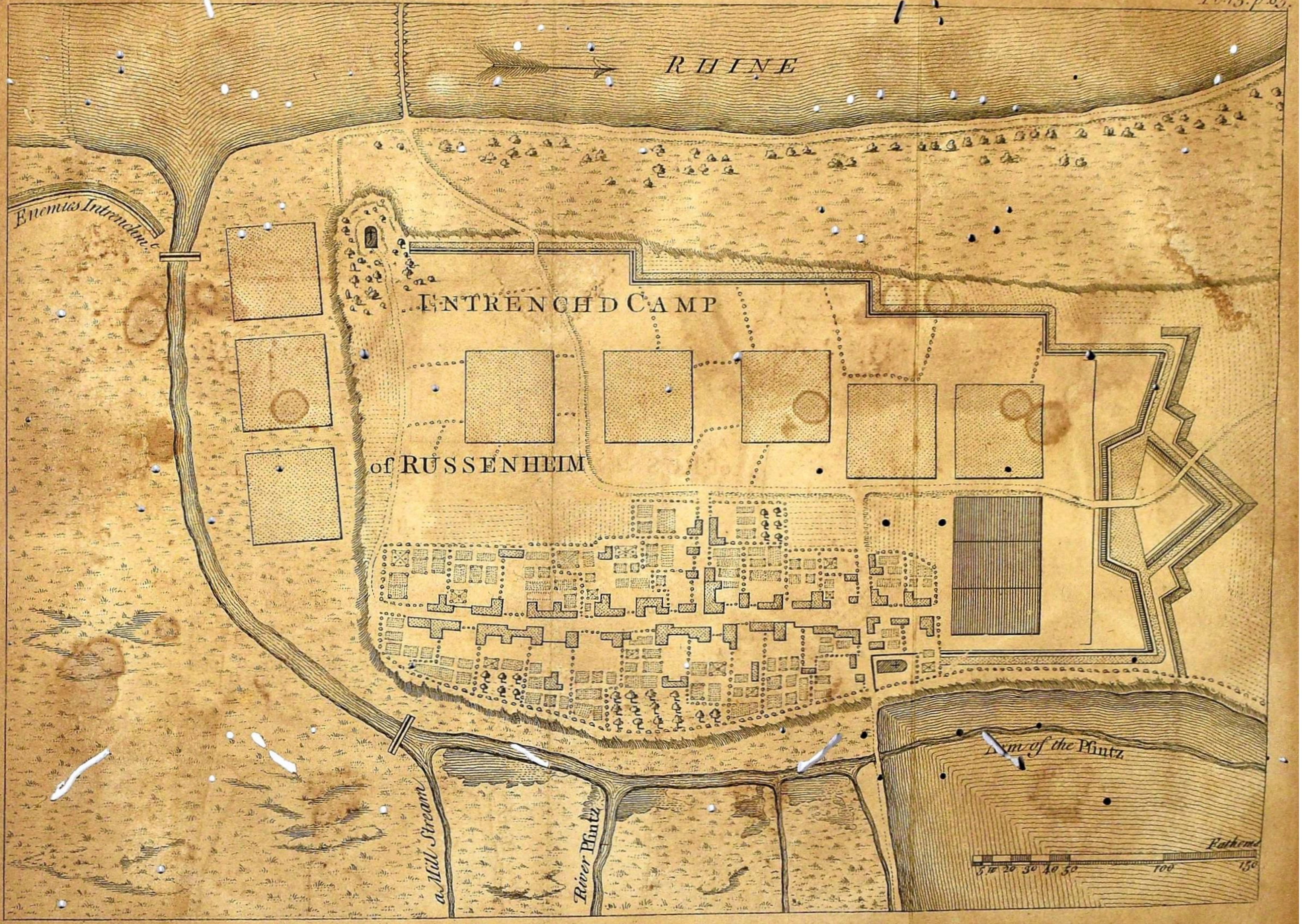
I here ſuppoſe that 10 fathoms, reduced to eight or nine by the thickneſs of the parapet, are not ſufficient to flank a redan; for the principal difficulty, after all, only conſiſts in the ſmall extent of the front. We could not extend it to the *Rhine*, in a right line, without being commanded in the meadow from the height, but it may be prolonged to the ſide of the height, which removes all obſtacles. The draught annexed ſhews this prolongation.

The manner is very ſimple, and perhaps new, to do without baſtions on the angles, let them be ever ſo acute.

Beſides, if redans are ſufficient to flank common intrenchments, I doubt whether they are ſo good to be uſed in an intrenched camp, which is made to be defended with very unequal forces, and having in propor-

tion

Pl. 13. p 85.


RHINE
Enemies Intrenchm.t
INTRENCHD CAMP
of RUSSENHEIM
a Mill Stream
River Plintz
of the Plintz
Fathoms
5 10 20 30 40 50 100 150

tion leſs extent, ought, when poſſible, to be fortified with more care.

VI. I hope it will not be thought I want to commend my firſt ſcheme; for though I think it better than the ſecond, yet it is far from being perfect.

I here remark the defects of forts; the one, which is the ſubject of this article, depends on the placing of the line; the other, more eſſential, which regards the method of fortifying it, and ſhall be treated of in ſome of the ſubſequent articles, and in chap. VIII.

I make it an eſtabliſhed rule, that the head of the camp ſhould, if poſſible, be at leaſt 50 fathoms from the interior part of the intrenchment, whereas in the plan it is but 25. The camp of the dragoons, reduced to 69 fathoms in front for three ſquadrons, is a little crowded, and beſides, is on the right againſt the branch it muſt defend, and its rear towards the village.

Laſtly, there being only 120 fathoms from the angle of the left demi-baſtion to the *Rhine*, it may be aſked, why the front is not continued to the *Rhine*, ſince that line, about two thirds ſhorter than that which runs towards the chapel, would incloſe more ground?

To this I anſwer; my deſign was to have brought the fortification more forward, by which means the troops there, and in particular the dragoons, would have had more room, but I was not maſter: it was thought neceſſary to have as little parapet to line as poſſible,

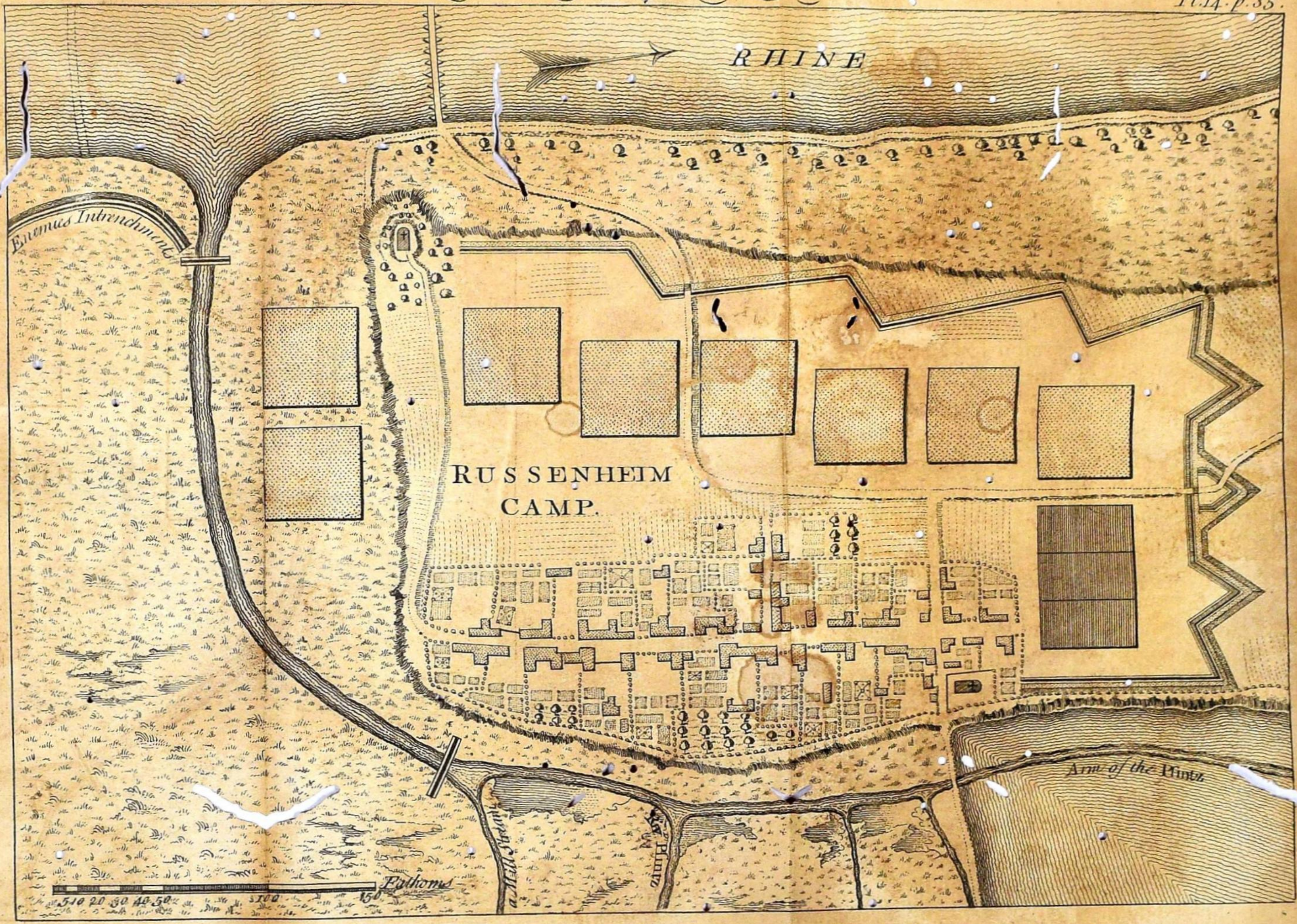
possible, and that it could not be done, but by contracting the camp.

I doubt whether these defects are here of any great consequence, I know that a common intrenched camp, or a line, should be defended by a large body of troops, drawn up in order of battle; and as it is a useful and durable work, should have room for all sorts of stores: I contest none of these reasons; but with a little reflection, it will be found, that this was not exactly the case here. For this post was properly but an intrenched village, which could not serve to keep stores, and there was no reason for keeping it long, and in effect, was abandoned long before the end of the siege of *Philipsbourg*.

As to the left branch, I might add, that I preserved by that the superiority of the ground; that, had the front been extended to the *Rhine*, I should have run the risque of being plunged from the rising ground, and this part of the intrenchment, though much shorter, required much more work than the other; besides the addition of a ravelin, it must have been constructed much stronger, to be able to resist cannon. But I honestly declare, that having only reconnoitred the ground in general, that scheme, as simple and natural as it may appear, did not strike me in the least.

VII. These replies, for the most part, appear rather excuses than reasons; which have occasioned a third plan; whose front is a crown-

2d INTRENCHD CAMPS.



crown-work, traced after the common method, except the flanks, which are perpendicular to the lines of defence. It does not reach beyond the high ground, to avoid being plunged, but the return of part of its branch supplies that with little expence, and without inconveniency, as it is flanked and covered by the rest. Plate XV.

The front of the camp, as in the others, is only 25 fathoms from the intrenchment, because I believe it is sufficient here; the cavalry placed as usual in the second line, are 50 fathoms from the infantry, at the nearest place, and have more room on their flanks and rear.

This new design, even reckoning the increase of the ravelin, has no more extent than the first; it is then preferable, as it incloses more ground. Ten battalions and six squadrons have here more room, than troops by a fourth less, have in the other.

As so considerable a body of troops are capable of undertaking some extraordinary enterprizes, and it is always material to shorten the time they lose in filing off as much as possible, I have placed a gate in each curtain, and one on the left, near the branch, which being less seen by the enemy, may also be esteemed an advantage.

VIII. This plan, only given to shew how the inconveniencies of the former may be avoided, is indeed exempt from them, yet all are defective in several material points.

We

We cannot attend too much to the flanks, since in them consists the principal defence: these are very large and well directed, but what advantage is reaped from them? as there is only 5 or 6 fathoms between the faces and the counterscarp for them to play upon, the rest of course fires on the ravelin.

This ravelin, necessary to cover the barrier, is more hurtful than useful: it defends the access to the faces I allow, and if we suppose a regular attac, it may be of service; but as we are here more exposed to a storm than a siege, and, as in this case, it is very dangerous to stand your ground in a detached work, the best way will be to retire with your troops, the moment of the assault, to avoid confounding your own troops with the enemy, or seeing them rush in through the barrier.

The flanks having thus their full liberty, the besiegers will be exposed to a dreadful fire, while in the ravelin: but then those opposite the faces will be the less.

These bastioned fronts have this inconvenience, the ditch is so large (in proportion to the rest) between the ravelin and the curtain, that the excavation becomes tedious, and wheel-barrows, or hand-barrows must be employed to transport the earth to the proper places. To remedy that difficulty, I practised the following scheme, in a parallel case.

IX. In *April* 1735, lieutenant general *Quadt*, ordered me to make a ſcheme for fortifying *Spire*, where he commanded, together with a retrenched camp. I ſhall ſpeak here of this laſt only; the ſituation was very favourable, no better could be wiſhed than that between the *Spire* back, and the new back.

This poſition, in regard to the place, was as convenient in large, as that of *Ruſſenheim* in ſmall: I made the front about 500 fathoms, it commanded, and was more extenſive, than the ground by which it can be approached.

It was neceſſary to occupy the tower of *Spire*, by way of an advanced guard or poſt, by which the enemies motion can be diſcovered as far as the wood: but to be abandoned in caſe of a general attac.

A ditch of 30 feet wide, and 9 or 10 deep, runs cloſe to this tower; this is a great obſtacle, eſpecially, for the horſe to paſs under the fire of cannons. The camp could not be made nearer to the town, without loſing in every reſpect the advantage of the ground.

The right branch deſigned to make part of the lines, traced on the ſide of the river, which I had before received orders to reconnoitre, was to have been covered by an inundation. Two heights run along-ſide of it; I followed the loweſt, not to crowd the figure, and to be nearer the water-ſide, it is higher than all before it by ſome feet.

The

The left extends along the *Neuback*, which in that place was 15 feet deep, and 9 fathoms broad, it can overflow the meadow, adjoining this branch, 4 or 5 feet high.

The *Palatines* tower is ſo near, that I thought it ſhould be joined to the line, as it commands an extenſive proſpect, its communication flanks all within reach, and covers one of the dams neceſſary for the inundation.

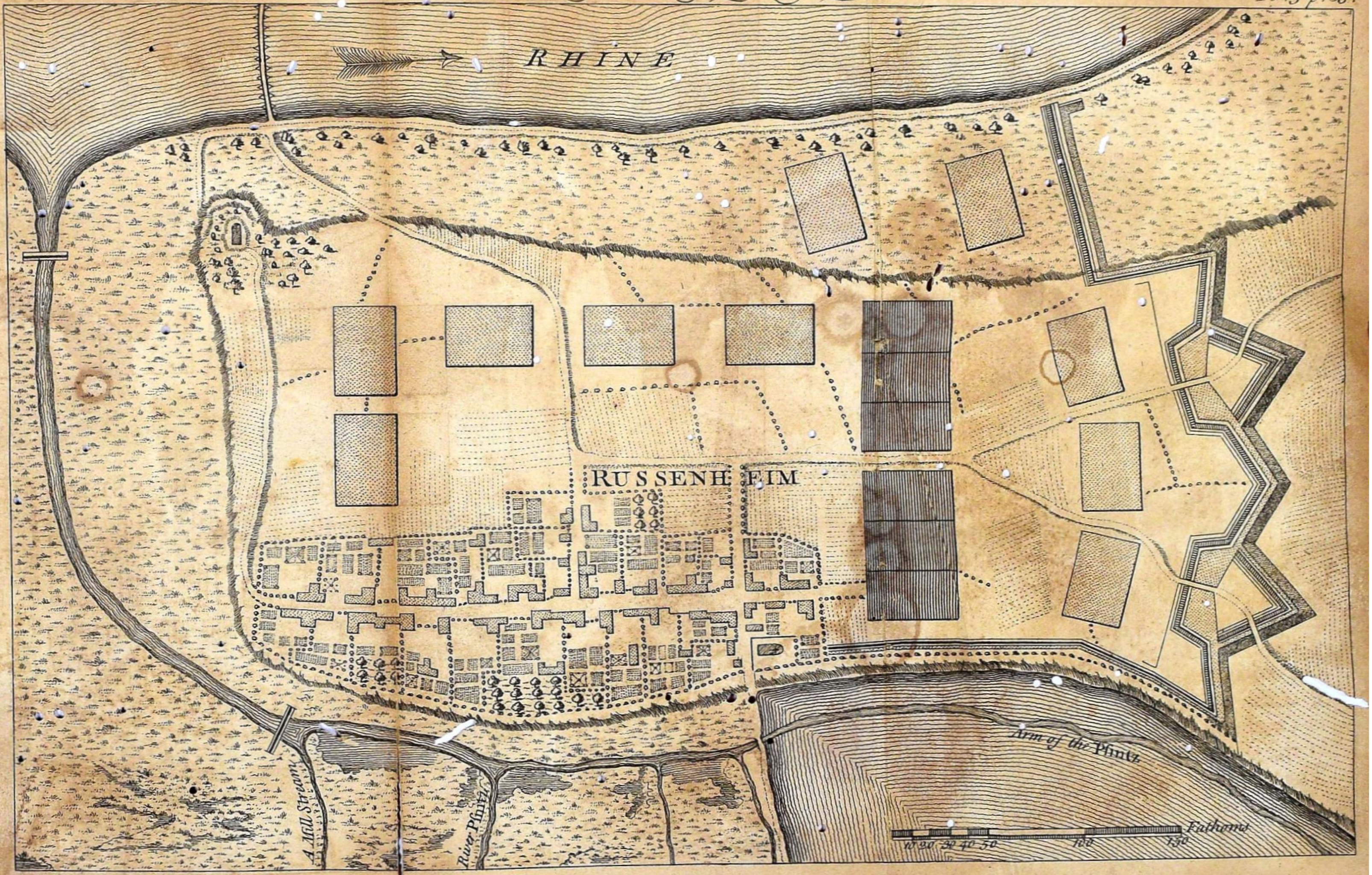
Laſtly, ſo favourable a ſituation, as to the plan, would be perfect in all reſpects, if theſe advantages were not in ſome degree counterbalanced by an eſſential defect; but as my deſign is to quote examples, and not give the hiſtory of the places, a longer detail would be as foreign to my ſubject, as the explanation of the motives we then had in view.

I could not ſuppoſe an attac in front only as at *Ruſſenheim*, and I had reſolved to make it with baſtions, but being at leiſure to trace my ſcheme on paper, I diſcovered the inconveniency of removing ſo much earth; and by making the ditch parallel to the faces; there were parts that could not be ſeen or defended.

This circumſtance did not diſcourage me; I therefore ſloped this troubleſome part of the counterſcarp in form of a *Glacis*, and that the fire of the flanks might have the more effect, I placed the paſſages of the gate at the extremity of the faces of the ravelins. The plan will explain the reſt: I thus corrected

Pl. 15 p. 85.

3d INTRENCH'D CAMP.



rected my baſtioned fronts in ſome meaſure, but I am ſenſible that I only remedied one part of their defects. We ſhall treat more ſatisfactorily on this method in chapters 7 and 11.

OBSERVATIONS on the fifth chapter.

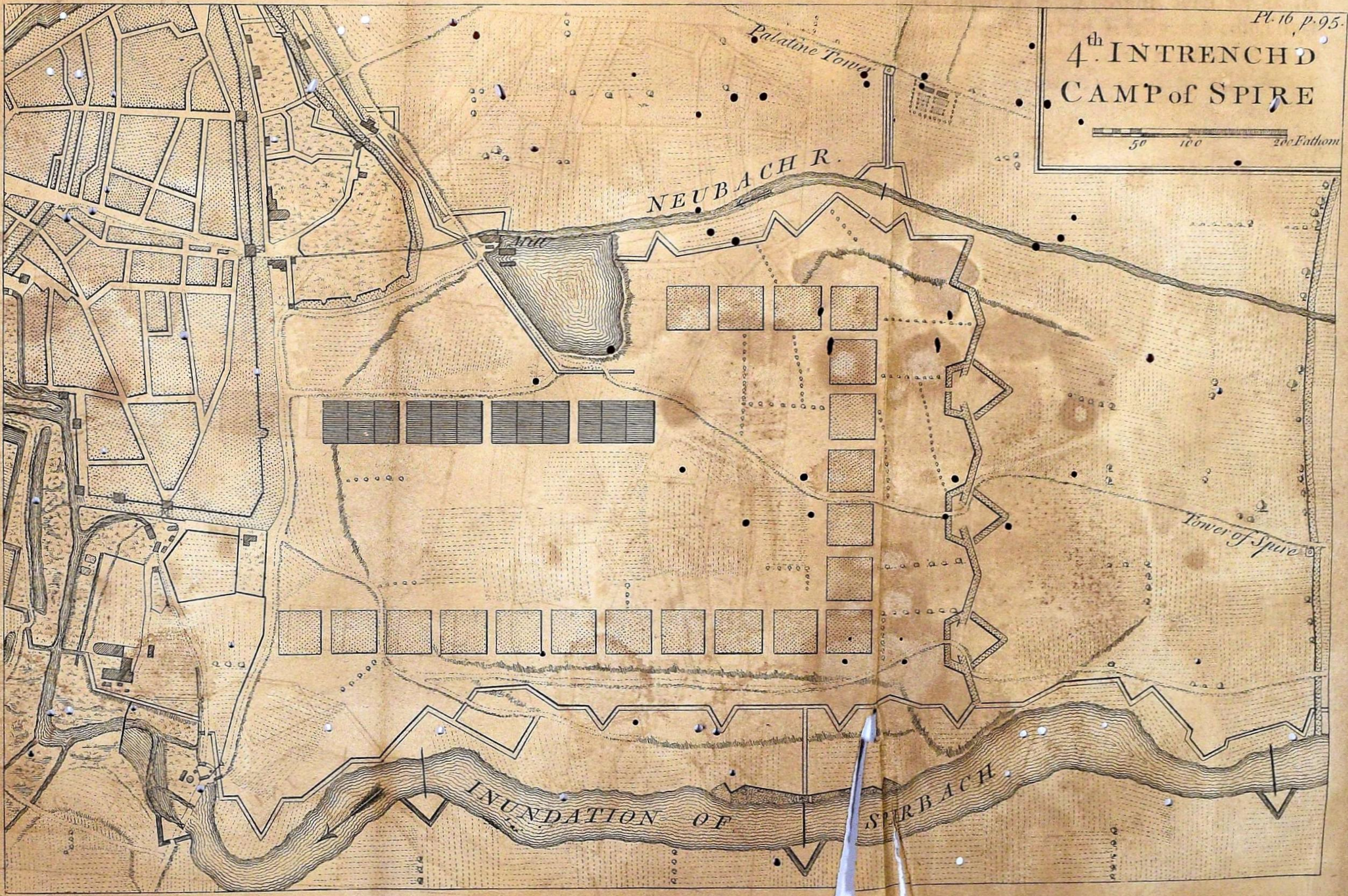
The author obſerves, that the ancients formed their camps into ſquares, or nearly ſuch; but as the preſent manner is to contrive them ſo as the troops may be placed in two lines, the ſquare form cannot be obſerved. I know it is a maxim of the moderns, to encamp the troops in the ſame order as they are to fight in, that is, in two lines; the foot in the middle, the horſe at the wings, and the body of reſerve behind. As the preſent manner of drawing up an army in order of battle may be, and has been conteſted by men of great knowledge and ability; the ground will not always permit to form ſo great a front; nor will there be always found a proper ſituation to incamp in this manner. M. *Saxe*'s manner of drawing up an army is a ſufficient proof, that the modern cuſtom is not ſo advantagious as many may imagine. It is therefore the ſituation of the ground that ought to determine the manner in which an army ought to be drawn up, or to incamp; when the ground is convenient, they ſhould form a ſquare camp; becauſe it requires the leaſt work to intrench it,

it, as we have ſhewn in a former obſervation. In doing this I can ſee no inconveniency to form any line of battle whatſoever: for I ſuppoſe, that as ſoon as a camp is formed, the ground for drawing up the army is pitched upon before the camp, and the order of the troops to march out determined: and in caſe the enemy ſhould attempt to force the camp, no better form can be pitched upon to defend it than the ſquare one.

To form a retrenched camp near a town or village, is very advantagious in many reſpects; it furniſhes room to place magazines for ſtores, forage, baggage, and for the ſick and wounded; the houſes and buildings cover the flanks of the camp, which therefore may be made more compact than could be done otherwiſe. Such a camp covers alſo towns, when fortifications are not ſufficient to reſiſt an army. As for inſtance, that at *Dunkirk*, which covers that town on the land ſide; its ſituation being ſurrounded by canals and inundations, that 15 or 20,000 men in it, could not be taken by an army ever ſo great.

When a camp is ſo ſituated, as cannot well be approached but in the front, the author ſeems to be doubtful, whether that front ſhould be fortified by a line with redans or with baſtions; the firſt manner has leſs defence, and requires leſs work; and on the contrary, the baſtions are able to make a better defence, as may be ſeen in Plate 15; but it requires much time, and a great deal

of


Pl. 16 p. 95.
4th INTRENCH'D
CAMP of SPIRE
50 100 200 Fathom
Palatine Tower
NEUBACH R.
Mill
Tower of Spire
INUNDATION OF SPIRBACH

of labour to remove the earth out of that part of the ditch before the curtains; and tho' the flanks are large and well diſpoſed, yet as the ditch before the faces is but narrow, and the ravelin ſo cloſe, they can make but a very ſmall defence. I wonder that an author, of ſo much experience as Mr. *Clairac*, ſhould commit ſo many miſtakes, before he could find out the manner of correcting this inconveniency. He was ſenſible, that a front with baſtions was much preferable to one with redans, in all other reſpects excepting the want of room for the fire from the flanks to extend as far as it ſhould. There need not have been occaſion for ſo many examples as he has given to ſee; that by removing the ravelins a little farther from the curtain, and to ſlope the ditches of the faces near the ſhoulders, it would remove that defect.

The author ſays, that the ſpace each regiment takes up in a camp muſt be known before the retrenchment can be made; but as the particulars he gives relate to the *French* army, which are different in ours, we ſhall give here ſuch as are neceſſary to be known upon ſuch occaſions.

The depth of a foot regiment incamped, conſiſting of 9 companies, each of 100 men, computed from the ſerjeants tents to the rear, is 200 yards, and the front 245, including the battalion guns. But if the regiment conſiſts of 9 companies, 70 men each, the depth

is likewiſe 200 yards as before, but the front is only 150, including the battalion guns.

The front of a regiment of dragoons incamped, conſiſting of ſix troops, forming three ſquadrons, with the light troops, takes up 200 yards, and the depth 258: the interval between two regiments of foot or dragoons is 60 yards. The particulars of the foot and horſe camps are foreign to our purpoſe; but thoſe who are deſirous to know more of this matter, may conſult the military diſcipline, publiſhed by *J. Millan*, where they will find plans, &c. of the preſent incampments for horſe and foot.

CHAPTER THE SIXTH.

I. *Different uſes of lines.* II. *Objections and anſwers to thoſe that cover an army.* III. *Thoſe that cover a country.* IV. *Thoſe that are deſigned for a new ſyſtem of a defenſive war.* V. *Neceſſity of ſupporting the extremities of theſe lines, and how.* VI. *Diſtance of lines, from heads of camps.* VII. *Defects of common lines.* VIII. *Means of correcting them.*

I. THE uſe of lines may be divided into different claſſes; the one proper to hinder ſuccours, or to curb the enterpriſes of a large and active garriſon during a ſiege, concerns the attac of places only, and conſequently does not belong to our ſubject.

The

The other, which few authors have mentioned, regards the rendering an army formidable in a retrenched camp; to prevent the enemy's excurſions, by oppoſing an impenetrable barrier; or laſtly, to ſecure an army, ſo as to keep upon the defenſive with ſafety, if thought neceſſary. Though an engineer is ſeldom acquainted with the general's deſigns, even in this caſe; yet, as he ought not to form any ſcheme without being able to anſwer any objections that may be made againſt his works; we ſhall begin to examine here the different opinions, commonly alledged for and againſt theſe different kinds of retrenchments.

II. To ſupply by art the defect of a bad ſituation, neceſſarily to be occupied, ſtands to reaſon; wherefore to fortify the camp of an army cannot, by any ſhew of reaſon, be blamed, provided the works are not too extenſive, are well directed, and ſo diſpoſed, that the army may conveniently make any motion upon occaſion.

Theſe conditions which include the whole, leave ſcarce room for any objections; but their execution is not always eaſy. Suppoſe there are reaſons that an army ſhould keep upon the defenſive, and avoid an engagement; it is neceſſary to find either an inacceſſible camp, or a poſt which can be attacked no where elſe but in a front well fortified in every part. There is I believe no other alternative; yet this may not pre-

vent our applying the following words of M. *Feuquieres*, which in fact are as applicable here as to lines of the third kind. *An intrenched army*, says he, *cannot sally out but by a small front; and consequently the enemy in his approach, being free in all his motions, may make them as hazardous as he pleases, without fearing the least inconveniency: I conclude, that an army which is straitened in all its motions is always inferior to another, tho' equal in number, which can move with an entire liberty, and may run any risk with impunity.*

This maxim is worthy of its author; I have already declared that the application may be just; but being unable to hurt an enemy, is only an inconveniency to which we may oppose the grand motive *necessity*, which according to our supposition obliges us to attempt every thing to avoid an engagement. M. *Feuquieres* is also so far from blaming this practice, that he says, there are examples of batteries being raised, and even trenches opened in form, to force an enemy from their intrenchments, thrown up for want of a good situation; an enterprise which, in his own words, "always supposes a great superiority "in the assailants, and even a necessity of "coming to action, which is ever attended "with a great loss of men."

If there are no reasons for avoiding an action, but only to balance the superiority of numbers by fortification, then some detached works, whose quantity and strength, determined

termined by this inequality and situation, may be sufficient, whence the preceding objection has no weight: but are there no others? "Nothing enervates the courage so much," says the ingenious * author in the preface to a new system of fortification, "as to think "one's self on the defensive; because it is very "natural to reason thus; I defend myself, "consequently then I am in danger, or rather I am the weakest; but an idea of "danger, and a knowledge of weakness, "disheartens the most brave."

This is true, speaking in general, and we see the consequence that may be drawn from it, even in the case we are now treating of; but is it always in a general's power not to be on the defensive? and so far is fortification from being a discouraging testimony of our weakness, that we may regard it as a remedy to supply its defects? "The shovel and the "Pick-axe, says M. *Folard*, speaking of this "kind of war, are the resource of the weakest, or of those that would not hazard an "action; they are the only arms by which "they defend themselves, and the best to "hinder the effects of others."

III. Lines, of the second kind, fall under the same objections, and are even more exposed to censure. Their principal design is to defend the country they cover from contributions; to have it in their power to raise

* *Le Pere Castel, Jesuite.*

 them;

them; to preſerve a communication from one place to another, without the neceſſity of eſcorts; and to render theſe places not liable to be attacked, as long as they ſubſiſt.

M. *Feuquieres* pretends, that all theſe advantages, except the laſt, are not real; or are counterbalanced by great inconveniencies; he thus explains himſelf.

" Experience, ſays he, has frequently con-
" vinced us, that theſe lines do not hinder
" a country from paying contributions, ſince
" to eſtabliſh it there needs only an oppor-
" tunity of forcing them once, during the
" whole courſe of a war; after which, tho'
" the troops that forced the lines ſhould be
" obliged ſuddenly to retire, the contribu-
" tion has been demanded; and in a treaty
" of peace, if made with any equality, they
" muſt be accountable for the ſum impoſed,
" tho' not raiſed; thus lines are of no uſe
" in guarding a country from contribution.

" The ſecond reaſon, viz. that of eſta-
" bliſhing contributions in an enemy's coun-
" try does not hold good. It is not the
" parties that ſally from lines, but thoſe
" from fortified places, that levy them.

" That of facilitating a communication
" from one place to another, continues he,
" is ſomewhat more apparent, for thoſe who
" would go without eſcort under cover of
" theſe lines; but if it is for the ſecurity of
" convoys, then that facility is only appa-
" rent; for if a prince reckons what the
" con-

" conſtruction and maintenance of theſe lines
" coſts him, and the quantity of troops they
" require for their defence, I am thoroughly
" perſuaded, that he would find theſe troops
" more uſefully employed in guarding places,
" eſcorting convoys, and with the army,
" than in guarding theſe lines."

I have before obſerved, that this author ſays nothing againſt that eſſential advantage, of preventing places ſurrounded by theſe intrenchments from being inveſted.

Such an authority is without doubt reſpectable; but theſe maxims ſeem to be advanced in a very general manner. There are lucky ſituations, ſuch among others, are thoſe from *Bergues* to *Dunkirk*, and from the mountain to *Lauterbourg*, which being carefully fortified, would prevent their being forced or penetrated by a ſmall body of men ever ſo bold; therefore ſuch lines would prevent contributions being raiſed.

They have alſo the means of impoſing contributions; for it is not clear, why a party ſallying from thence have not the ſame privilege in that reſpect, as others.

Laſtly, if as in the firſt caſe, ſuch lines join to fortified places, theſe places become unattackable; and if, as in the other, they join to an encloſed town, but little fortified, it cannot well be ſupported, but by ſuch aſſiſtance. I agree that this cannot be on the *Loutre* without a certain number of troops; but are they entirely loſt there? no, ſince

they cover all lower *Alsace*, they keep in awe, and even distress a body of troops, at least equal to them, unless the enemy abandons all the country before them.

The lines from *Bergues* to *Dunkirk* have this further advantage, that even in the presence of an enemy, the garrisons of these places, and the adjacent posts, may be sufficient to guard, or at least to defend them.

Will not every one agree, that it is much better to do without an escort, than be obliged to take one, were it for no other reason but that they may be beat?

To all these objections, M. *Feuquières* had added, that of the expence, which he says, exceeds what the contribution will come to: this can but very seldom be true; but besides other advantages which may be drawn from them, we must add, that of depriving the enemy of that contribution, which they otherwise could make, either in money, subsistence, or labour.

IV. The kind of lines, M. *Feuquieres* most briskly attacks are those, which according to him, have of late years established a new system of defensive war. "Experience, says "he, has shewn the falsity of this system, "which consists in two incontestable points."

The first is that we mentioned of armies enclosed and confined in intrenchments. "An army (adds he) in lines, is never compact, because it must defend a great front, "and consequently when surprized in one part,

"part, either thro' the nature of the coun-
"try, or the night, which may conceal the
"enemy's march, it is certain this attac can
"only be supported by one part of the army;
"for the rest cannot march to their assist-
"ance where the real attac is, but with great
"difficulty and in column, which is dan-
"gerous."

He afterwards remarks, that these lines being greatly extended, and constructed with the view already mentioned, must greatly weaken an army to guard them; in consequence of which they have been forced every time they have been attacked; and besides, their excessive extent preventing their being sufficiently furnished with redans and other works, they cannot be good; that is, they cannot be fortified with sufficient care.

I shall not take upon me to answer these objections, so solid in themselves, while they only regard ordinary cases; I agree, that as to their extent, simple intrenchments of four or five leagues are not sufficiently fortified to secure an army tho' equal in number from being exposed; but supposing a favourable situation, these lines do not much differ from the second kind; we may therefore alledge in their favour, what we have said of the others.

The lines of the *Loutre* (*a*) for example, are

(*a*) These lines are the same as those of *Vissembourg*, which

are more than five leagues long; yet if they were in the ſtate they might be put in, with leſs than two months work, 20,000 men could defend them with ſucceſs, againſt the moſt numerous army.

It is true, they have one of theſe conditions which *Feuquieres* afterwards demands, *viz.* to reduce the enemy to certain places of attac, and it will be difficult, even to find any but one that is practicable; and though they are long, yet they ſupport as well the only bad place found in them, as they are alſo ſupported by it.

I believe then we may conclude, that as there is not any kind of lines, to which we cannot make ſolid objections, ſo there are none from which we cannot draw great advantages, when art is ſeconded by nature; I ſay ſeconded by nature, for if they can be flanked and enfiladed, it is plain they are of no advantage. I am convinced, and ſhall always think, that lines raiſed in dry, even and open ground, ſuch as a vaſt plain, are more dangerous than uſeful, when their extent is more than the front of an army would occupy in battle. As to intrenched camps, we know that *Feuquieres* did not find the attac ſo eaſy, which is equal to an approbation; *Folard* and *Santa Cruz* ſpeak of them,

which *Feuquieres* mentions in his remarks; I do not know that they have been either forced, or abandoned ſince 1706, when taking the advantage of the ground they were covered by inundations.

the

the first as *a practice of the antients, which we have left off, for another much less advantageous*, namely, that of grand guards, posts and detachments in front; the other as the best means of easing the troops; to be capable of making great detachments; and not to engage but when it is thought to advantage, and not *when the enemy pleases*.

V. The chief attention in planning lines, is, as was before observed, to support the extremities, so that they neither can be flanked, nor the enemy attempt it.

This precaution is the more or less necessary, according to the use these lines are designed for: if they must cover a whole country, as those of the *Loutre*, a vast and thick forest, which is yet better for being marshy; a chain of mountains with narrow passes, which are easy to be defended; a broad and deep river, or any such objects, are of great advantage.

These advantages are absolutely necessary in this respect, for they are no guard against incursions without them, and such intrenchments, being mostly of a very great extent, in proportion to the number of troops that guard them, they are almost only supported by the goodness of their fortification; so that the enemy might not have time to flank them, before their too weak and much dispersed defenders have time to collect themselves to make them repent of such a movement, even if they were strong enough for such an enterprize.

These

These positions, both favourable and indispensable, are scarce, I agree, but such lines ought to be seldom used: as to those designed only to cover an army, which will not come to action but with that advantage, a fortified place, a town enclosed with walls, a country castle, a little wood that may be filled with infantry, a morass known to be impracticable, a river with deep banks, or muddy, are sufficient: these may yet be supplied, as we have seen, by covering the flank by an intrenchment with redans, or by felling.

There are even examples that a general, not content with these precautions, has intrenched himself in the rear, and thus shut himself up on all sides, which forms a new kind of intrenched camp, fortified according to the nature of the ground; but these examples are not common.

VI. If in tracing lines we are obliged, at least in the principal parts, to follow a camp already fixed, which sometimes happens, or that some village must be enclosed, which is not so rare, it is equally necessary for an engineer to know what space should be between the intrenchment and the front of the troops.

At *Philipsbourg*; for lines of circumvallation not differing materially from these, but in their circular figure, what is agreeable to one is so to others; at *Philipsbourg*, I say, this distance was fixed at about 65 fathoms, and more was not left between the intrench-

ment

ment and the village of *Oberhausen*, though there were troops encamped between them; but it must be observed, that this distance is contracted as much as possible, the better to unite the forces.

M. *Vauban*, in his treatise on sieges, has fixed this distance at 100, or 120 fathoms; this he afterwards extends from 60 to 120, in his treatise on the attac of places: it may be dangerous to give more or less; for in the first case, the troops will be too far from what they are to defend; and in the second they will not have sufficient room to move in, and to leave a passage in their rear, for a body of troops to march wherever its assistance may be wanted, to support a part giving way, or too hard pressed: I believe then we may determine this distance (unless in particular cases) from 80 to 100 fathoms.

As to the parts opposite the villages, it is necessary, in my opinion, to add the depth of the camp to this distance, if the depth does not exceed 60 or 80 fathoms, counting from the bells of arms, or standards, to the subalterns tents, or to the kitchens at least, included.

VII. All lines may be fortified in the same manner, not excepting those of circumvallation and countervallation, for they only differ from the rest in their use.

The common and almost universal method is to flank them by redans. In open ground, for those of circumvallation, M. *de Vauban* allows Pl. XVII. Fig. 1.

allows 120 fathoms, from the point of one redan to that of the next; 30 fathoms for the gorge, and 22 for the capital; which makes the faces about 27 fathoms: it was in this manner we traced thoſe at *Keil* in 1733, and nine years afterwards at *Nider-Alteich* in *Bavaria*.

The flanked angle of theſe little works is 68 degrees 34 minutes, which is open enough; but ſuppoſing the lines of fire to ſquare on the faces, as their angle with the curtain is 34 degrees 17 minutes, they paſs more than 30 fathoms before the middle of the curtain, and do not croſs the capital of the oppoſite redan but at 49 or 50 fathoms from the point.

It muſt be further obſerved, that ſuppoſing, as we generally do, the range of a muſket 120 fathoms, the collateral fires, ſo far from croſſing on the capital, leave more than 7 fathoms between the two neareſt.

From hence then, reckoning the range of ſhot as before, and ſuppoſing alſo that the ſoldier fires directly before him, each curtain forms the baſe of an *Iſoſceles* triangle from 30 to 31 fathoms perpendicular, which is not flanked, and before each redan there is a ſpace of 30 fathoms broad, communicated to another of the ſame breadth, by a paſſage of 11 or 12 fathoms, which is not raked from any part; this will be better underſtood by the plan annexed: laſtly, the ditches have

have ſo oblique a defence, that it is evidently of very little effect.

From the freedom with which I explain myſelf, I hope it will not be thought I attempt the critic; it is a title that would as ill become me as I deteſt it: I quote and examine with ſincerity; let the judicious reader decide: in a word, my own inſtruction, and that of my brother officers, is, as I think I have already declared, the only motive I propoſe in diſcuſſions of this nature.

So far from entirely rejecting a method adopted by ſo great a maſter, and ſo univerſally received, I readily allow it is ſufficient, if we ſuppoſe a large train of artillery; in effect, the moſt of theſe inconveniencies diſappear by this means; cannon commonly placed in the redans, make its principal and almoſt only defence, and not firing at random as ſmall arms do, the obliquity of the faces is not ſo great a defect.

We may yet alledge in favour of this method, that a front of 120 fathoms has only 144 of parapet, that is, one fifth more; which is an advantage, eſpecially when we are diſtreſſed for time, want of workmen, or have few troops for the extent of the parapet we ought to line: yet theſe advantages do not balance the defect of the oblique fires; and ſpaces not raked by any fire which we are commonly obliged to have in moſt field-forts, ſhould be regarded as very eſſential defects,

defects, and even inexcusable in all cases where they may be avoided.

VIII. After this declaration, or rather repetition, I think I may advance my own thoughts: experience has often convinced us, that a moderate genius is sometimes capable of adding, and even perfecting the discoveries of a great man; if the reader knew how thoroughly I was convinced of this maxim, I should have no reason to fear being suspected of presumption.

I have remarked four principal defects in the common method, and shall here mention them.

1st, The middle of the curtain is not flanked; but at 30 fathoms distance in front.

2d, The direction of the nearest fire does not cut the capital, but at about 50 fathoms from the flanked angle.

3d, The lines of defence being more than 120 fathoms, the fire which exceeds that distance may be esteemed as nothing.

4th, The great obliquity of the redan with the curtain hinders the ditch from being defended.

I greatly mistake; or a very little alteration will remedy the whole.

Pl. XVII. Fig. 2. It is only to brake the curtain in the middle, so that the saliant angle shall be on a line with the points of the redans, an operation as plain, as easy in practice.

The angle of the face, with the demi-curtain, being only 98 degrees 14 minutes, the

the parts reciprocally defend each other every where at a proper diſtance by a croſs fire, and the ditches are alſo defended: the middle of a ſtraight curtain, which we never attac by choice, does not here collect all the fires; they are thus diſtributed more equally, and even trebled towards the ſaliant angles, which are the weakeſt parts.

I cannot here paſs by one reflection, ſo juſt and evident, that I regard it as a maxim. The quantity of fire that can be drawn from any work, let us do all we can, is determined by the greatneſs of the extent; it is then only required to diſtribute it equally, or in proportion as the ſeveral parts require; which I think is here done.

Let us ſee at what rate we gain theſe advantages. The front being always ſuppoſed of 120 fathoms, has 154 of parapet, that is 10 more than the common method; I ought alſo to remark, that the rentrant angle will not be ſeen, whereas it was diſcovered, at leaſt obliquely from part of the oppoſite face. The connoiſſeurs may judge of the importance of this inconveniency, of which I ſhall ſpeak more at large in chap. 13.

OBSERVATIONS on the ſixth Chapter.

The manner of making lines, ſecuring poſts, and of intrenching the camp of an army, is what is here conſidered; alſo the reaſons for and againſt this practice; it is a

queſtion amongſt military authors, whether an army retrenched, or covered by a line, ſhould receive the enemy in them, or march out and meet him. Many examples are given in favour of the one and the other: but as this is too general a queſtion, it would be ridiculous to ſay that what ought to be done on any particular occaſion, muſt alſo ſerve on any other: the only way to decide the queſtion properly is then to come to ſuch particulars, as will enable us to judge, with ſome degree of certainty, when and when not the lines ſhould be defended. When the intrenchment is very extenſive, ſuch as circumvallation lines, and the troops have not an open or eaſy communication with one another, or elſe are confined in their motions, it is very dangerous to wait for an enemy in them, altho' he is much inferior in number; becauſe he makes his approaches in the night, alarms the whole line by ſeveral falſe attacks, to cover or conceal the real one: whereby every part of the line muſt be guarded alike; and one part may be carried, before any troops can be ſent to reinforce thoſe who are attacked. Thus the point being carried in one place, the defenders fall into confuſion, are ſo diſheartened as to give all over for loſt, and retreat wherever they can. Many examples prove what has been here ſaid; for inſtance, prince *Eugene* with 18,000 men drove the *French* out of their

their lines before *Turin*, although they were 72,000 ſtrong.

But when a general is obliged to be upon the defenſive, becauſe the enemy is ſuperior in number, and in the goodneſs of troops; or to guard a paſs that leads into a country he is to defend; it requires no great ſkill to know, whether he ſhould retrench himſelf in an advantageous poſt or not. If a general intends to engage the enemy, but not without having the advantage of the ground, he will naturally pitch upon ſuch a ſituation, where his flanks and rear are ſecure, either by the nature of the ground, or by works that are to be made. As to the front, he will either ſecure it with a good retrenchment, leaving proper openings, ſo as he may march out in a large front, or elſe make ſeveral ſteps, for the infantry to march over the parapet in order of battle, and openings for the horſe only to march out. Sometimes the front is ſecured by raiſing redouts at proper diſtances, with artillery placed in them; or if villages are in the front, they are to be retrenched, and lined with troops and artillery. This M. *Saxe* did at *Fontenoy*; where that village ſtood in the middle of the front, *Anthoin* on one wing, and the woods of *Barry* on the other; the wood was covered with felling of trees, and had a redout in it, and the villages covered by parapets and batteries. But when no convenient poſts are to be found in the front, redouts are made,

as the *Russians* did at *Pultowa* against the *Swedes*; altho' the last took some of the redouts, yet the great loss they sustained from their fire was the occasion of losing the battle.

If it is found necessary to guard a pass, or a particular post against a superior enemy, a good intrenchment is then highly necessary; but this cannot be done without a favourable situation, so as the accessible part may be well guarded and defended, otherwise the enemy might form several attacks, both in front and flank, with a superior number. But if there be only one accessible part, and that well retrenched, tho' the enemy should force them by their superiority, yet as this cannot be done without the loss of a great many men, the advantage will be on the side of the defenders, provided they can retire with safety. Consequently the retrenching an army is, generally speaking, advantageous, and often absolutely necessary.

The chief objections of authors against a retrenched camp are, that the army in it is confined in its motions, and cannot come out but in a small front; whereas the enemy, being at liberty, may hazard his motions as much as he pleases, without any danger of suffering by it, and attac either in one place or other. As to the first, it is supposed the army has sufficient room for moving with ease to what part they find it necessary;

ſary; and as to the ſecond, the works may be ſo contrived, either to march over the parapet in order of battle, as we have mentioned already, or to leave proper openings from diſtance to diſtance, ſufficient to march out in large bodies: and to prevent the enemy from availing themſelves of theſe openings, a traverſe is raiſed inwards, ſo as to cover them againſt the enemy's cannon, or to prevent them from forcing their way thro' them: and for a greater ſecurity cannon may be placed on each ſide to flank them, which being loaded with grape ſhot, will ſoon make them tired of their attac.

Intrenchments or lines are made likewiſe to cover a place indifferently fortified, and which ſometimes contains the principal magazines of an army, or to cover a conſiderable extent of ground, to prevent an enemy from entering into the country to raiſe contributions. Sometimes an army is obliged to retire before a ſuperior or victorious enemy; in ſuch a caſe, by intrenching itſelf near a town or village, for the ſake of quarters for the ſick and wounded, or to form new magazines, becomes neceſſary, provided the place cannot be attacked but on that ſide; an old wall, or a ſtrong building to place men and artillery may be of great uſe. This is the caſe at *Dunkirk*, which has an intrenched camp on the land ſide, ſurrounded by canals and marſhes, and may contain 25 or 30000 men very conveniently. This

camp covers the town entirely, which might otherwiſe be attacked by a ſmall army. Lines have been made in many places of ſeveral miles long, generally covered, in part by large rivers, and from one fortified place to another; but their defence becomes very precarious, excepting the attack can be reduced to certain places; for ſometimes they have been forced with very little difficulty; and at others, tho' the enemy has penetrated them, yet has been obliged to retire without being able to effect his deſign. The advantages of thoſe lines depend on proper ſituations, the difficulties of penetrating them undiſcovered, and on the capacity of the general who defends them; ſo that nothing certain can be ſaid for and againſt ſuch lines, without being upon the ſpot to ſee what can be done to ſecure them.

The different figures given to lines or intrenchments require particular conſiderations. For if an army is already incamped, the engineer muſt make his works conformable to the ſituation, and take care to have ſufficient room between the line and the front of the camp, for the army to draw up in order of battle, in caſe of an attack; the riſing grounds within cannon-ſhot muſt be occupied either by the line itſelf, or by ſome detached works, whoſe communication with the line is ſecure; or if a river is at hand to form an inundation, ſo as the enemy cannot poſſibly drain it: in ſhort, all advantages poſſible

ſible muſt be taken that the ground can afford; which requires more ſkill and knowledge than is generally imagined; and is therefore not to be found, but in an engineer of the firſt rank. As there is no ſituation, but what is ſtronger by nature in one part than in another, it is therefore neceſſary to fortify the weak part ſo much more, as to make its approach of the ſame difficulty as the others.

When a poſt has ſome natural advantages, the common lines with redans, at 120 fathoms diſtance (ſuch as fig. 1. plate 17.) will be ſufficient; but to ſuch parts as can be approached without any natural obſtacle, ſuch a line is not ſufficient. Sometimes the ſame ſort of lines are uſed, with two or three ditches before them, and the intermediate ſpaces are made full of round holes 7 or 8 feet deep, with ſtakes drove in the middle, as may be ſeen in the third plate of my attac and defence of places; and ſometimes theſe lines are covered with detached works, ſuch as redouts and lunettes. Our author propoſes two different manners of making lines ſtronger than the firſt, as may be ſeen in fig. 2, 3. plate 17. they however differ only in the length of the branches, which form the ſaliant angle.

The author lays down as a maxim, that the quantity of fire or defence that can poſſibly be had from a work, is always in proportion to it's extent; and therefore, it re-

mains only to diſtribute the fire equally every where, or proportionally to the exigency which ſome parts require, one more than another: this is undoubtedly true, in general, not only in lines, but in all fortifications whatſoever; but then this maxim cannot always be obſerved; for ſometimes the figure of a line is ſo determined by the nature of the ground, as not to be changed for a better, without falling into ſome conſiderable miſtakes. Suppoſe, for inſtance, a river paſſes before the camp, it's windings muſt be followed, otherwiſe an enemy might paſs it, where it is fartheſt diſtant from the line; or, ſuppoſe a bank, or riſing ground, it is plain the ſlope muſt be followed every where, or elſe the enemy may approach under cover; in theſe places, which cannot be flanked by the line, in ſhort, general maxims ought to be followed, when no other obſtacle intervenes; and conſequently, an expert engineer will chuſe, amongſt the various diſadvantages, thoſe that can be eaſieſt remedied.

CHAP.

CHAPTER THE SEVENTH.

I. *New ſchemes of lines, with redans.* II. *With Tenailles.* III. *More perfect.* IV. *With indented work.* V. *With redans and lunettes, their inconveniency.* VI. *With tenailles, and lunettes.* VII. *With broken tenailles and lunettes.*

I. THE alteration of the forementioned fires of the curtain produce another very conſiderable, which is that each front, being ſufficient for its defence, becomes in a manner a whole front; I will explain myſelf better.

The front of a fortification, with regard to the defence, is a collection of lines, contrived ſo as reciprocally to flank each other; but according to the common method, the curtain only fires right before, and the two faces which terminate it, are the only parts that have, or are deſigned to have, this property, the front cannot be complete, that is flanked throughout, if it is not compoſed of the curtain and two faces.

In the new plan, if the face defends the demi-curtain, it is alſo equally defended by it; ſo that ſuppoſing theſe parts were detached from the reſt, and that they cannot be attacked in the rear, they will be capable of ſupporting themſelves.

From

Pl. XVII. Fig. 3. From thence, we may without inconvenience give more diſtance from one redan to another, but I would in this caſe alter the conſtruction from the middle of one to that of the next; I would allow 150 fathoms, that is one fourth more, which in my opinion is the greateſt length to be given: as to the fire of the faces, I would make the capital of the redan (which alſo ſerves as a perpendicular to the brake) one fifth of the front, and one fathom more than half the capital, for each demi-gorge.

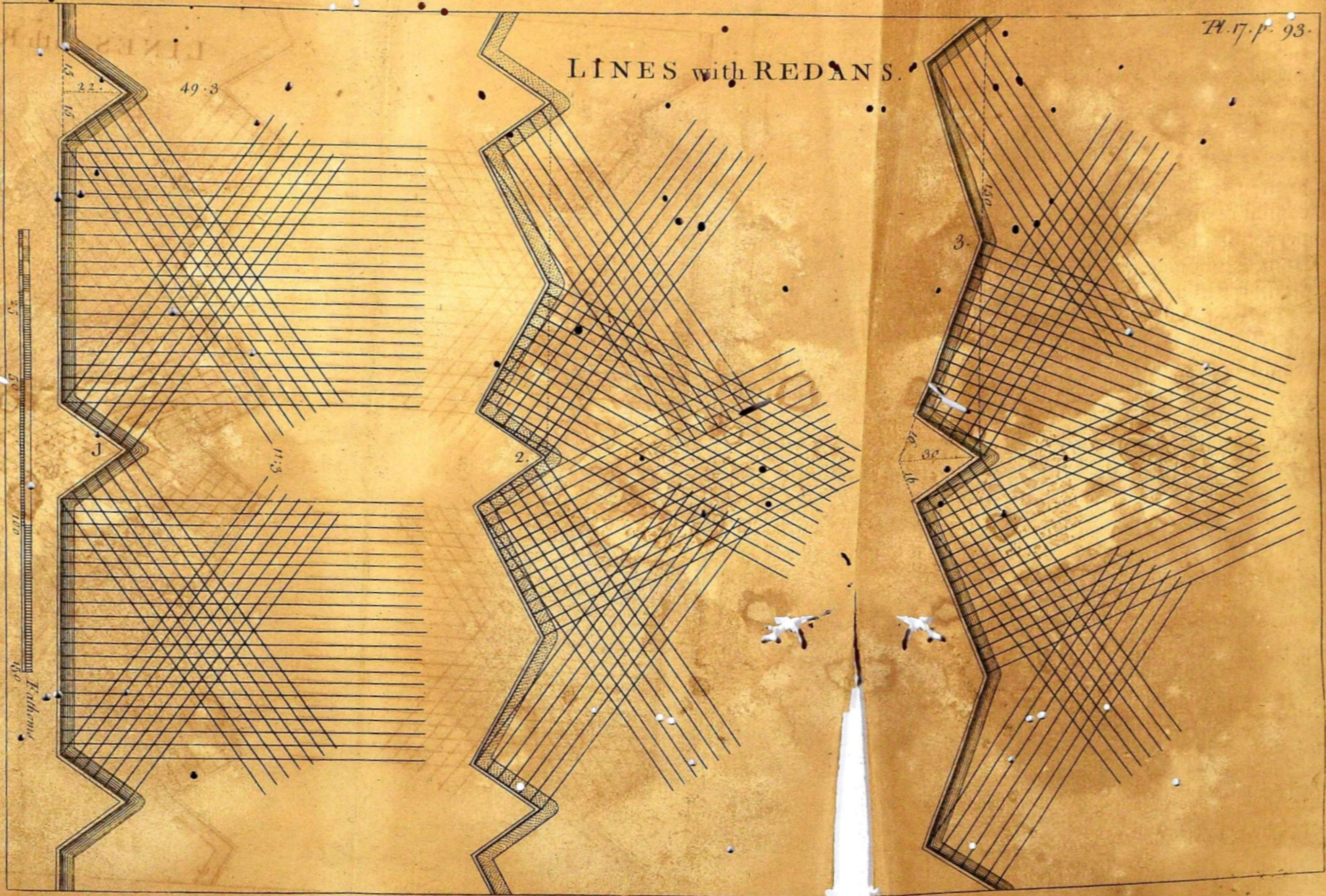
This fathom is to prevent the flanked angle from being too acute; which, without it, would be only 59 degrees 22 minutes; and now it becomes 63 degrees 24 minutes, that of the face with the curtain 99 degrees 54 minutes, and the length of the face will be more than 28 fathoms.

I think this method preferable to the old, by the direction and diſtribution of the fires, and the ſhortneſs of the lines of defence, all points equally eſſential. It does not much exceed it in reſpect to work, ſince the extent of the parapet does not exceed the length of the front, but by about 35 fathoms, that is, only five fathoms more than one fifth.

II. Theſe brakes remind me of the manner I traced an intrenchment of about half a league long, at the camp under *Landau*, in 1743: it was not the beſt I made in my life, but it is more generous to point out ones own faults than thoſe of others; I need

not

LINES with REDANS.



not fear being ſuſpected of magnifying them, and one is leſs embarraſſed for the turn and choice of expreſſions.

I was willing to follow, as much as I could, the ſide of a bank, about two feet higher than the meadow, my ſcheme was alſo to bring the river *Quiech* into the ditch. I received my orders on the ſpot, and it was to be traced out immediately.

It ſtruck me to make it in form of plain *Tenailles*, or ſwallow tails, which appeared the beſt, having fewer ſaliant angles, and theſe ſaliants being very obtuſe, were in no danger of being waſhed away by the water. Pl. XVIII. Fig. 1.

As to the fortification, I knew that the perpendiculars of two lines, which formed a rentrant angle, croſſed each other: I made no farther reflection, and fixing each front at 120 fathoms, the work was quickly picketed out; I forgot what I allowed for the perpendicular; but ſuppoſe about one fourth of the front, and on this ſuppoſition I will examine my plan.

The ſaliant and rentrant angles by this were 126 degrees 52 minutes, conſequently the direction of the neareſt fire, ſuppoſed to ſquare, forms an angle of 36 degrees 52 minutes, with the branch it ſhould flank; ſo that by this obliquity there muſt be 14 fathoms, where it does not touch the capital, and even ſuppoſing it long enough, it would cut it at about 90 fathoms from the ſaliant angle.

I fell

I fell then into all the faults I have found in the common lines with redans, (except that of the curtain) without gaining any thing more than 10 fathoms of extent by the *Tenaille*, and being leſs liable to be hurt by the current of the water: for giving 8 fathoms more to the perpendiculars, than what is allowed to the capitals of the redans, it is plain I was farther diſtant, at leaſt in the rentrants, from the edge of the bank I wanted to follow.

If the diſpoſition had not been changed, which hindered the execution, I ſhould not, I believe, have been the laſt to have perceived, that it would not have anſwered my intent; yet I ſhould have diſcovered it too late. How came it about? becauſe I had not time to trace my plan on paper, to examine the direction and range of the fires; a confuſed notion of the rentrant deceived me; I rejected the common method, deſigning to give ſome lines of better effect, and I made them worſe, or at leaſt very indifferently.

The ſame cauſe has, and will often produce the ſame effects. On theſe occaſions, we have ſeldom leiſure to draw out our plans, which would be a great advantage. A number of maxims, examples, analyſes, &c. in this ſcience, would ſupply that defect; but how are they to be obtained? we do not ſtudy this ſubject in fortified places, becauſe the object is not before us, and there are no books

books that treat of it. As to what we ſee in time of war, fatigue, different applications, and various other cauſes, often hinder our examining them ſo minutely as to gain any knowledge by them: beſides, whatever affinity there may be between field fortification and that of places, the laſt is not ſufficiently clear to explain what belongs to the former.

III. I experienced, as may be ſeen, what I have advanced; for if I had better known the properties of the *Tenailles*, or had time to examine them with my compaſſes in my hand, theſe faults could not have eſcaped me; I ſhould readily have found out from whence they proceeded, and perceived that to have remedied them, I need only to have ſhortened the front, and diminiſhed the opening of the angles. Pl. XVIII. Fig. 2.

I uſe both theſe means in the ſecond plan. The front is but 100 fathoms, and the perpendicular the third of the front: the line of defence makes an angle of 22 degrees 38 minutes, with the branch it ſhould flank, and it cuts the capital at 41½ fathoms from the ſaliant angle, ſo that the columns of fire of each front, after reciprocally croſſing each other, croſs alſo on a conſiderable part of one of thoſe angles, with one of the columns of the next front.

The extent of this figure, as in common lines, is only one fifth more than the right line. I leave the reader to compare the other advantages of theſe methods, and ſhall only

only add, that this plan would much leſs have anſwered my ſcheme of keeping cloſe to the ſide of the bank, than that I deſigned, as the length of the perpendiculars would conſequently have obliged me to retreat farther from it.

IV. Indented works, ſuch as I made uſe of in the ſecond intrenched camp of *Ruſſenheim*, may alſo form a new kind of lines; we ſhall examine their conſtruction, and the effect we may expect from them.

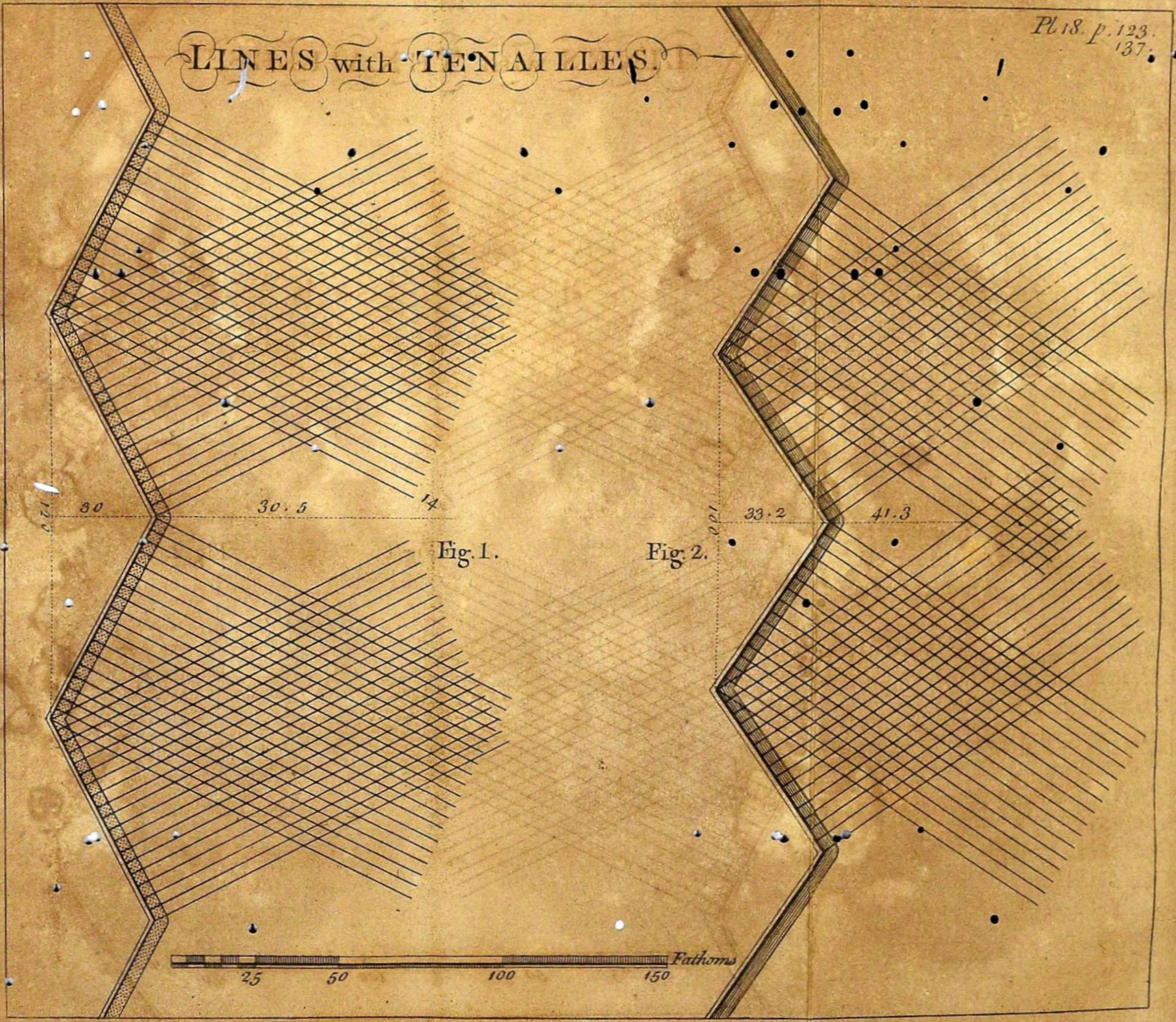
Pl. XIX. Divide the whole front into parts of 60 fathoms each; let fall a perpendicular from each of theſe points, of one fourth of that meaſure, that is, of 15 fathoms; draw the branch from the foot of one perpendicular to the ſummit of the next; advance 5 fathoms, on the foot of the branch, for the part that is to flank that branch.

The angle of the flank, with the branch, will only be 91 degrees 21 minutes, ſo that the line of defence will paſs but 5 or 6 fathoms from the adjacent flank'd angle, and as that will only be near half the range of the ſhot, it will cover the angle of the next branch oppoſite the flank.

Thus there being no part that is not defended by two preceding flanks, the length of theſe flanks, which is no more than 14 or 15 fathoms, appear to me ſufficient.

Theſe columns of fire, following each other, and doubling towards the middle of their range, have an uncommon effect, which

LINES with TENAILLES.



is ſtill greater, as it muſt be allowed, that when a diſtant defence begins to weaken, it is neceſſary to procure a ſecond nearer.

We may alſo reckon among the advantages of this ſcheme, that the ſaliant angles double in number to the common method, and flanked at half muſket-ſhot, advancing very little into the country, are leſs expoſed to the enemy; that on account of theſe ſmall projections, and the ſhortneſs of the branches, it is eaſy to follow a determined line, and to reap all advantages of the configuration of the ground; that it is the only plan, in which a direct fire runs parallel throughout and without interruption, and the only one, in which the fires are equally diſtributed.

Tho' theſe indents may in this manner be continued from one end of a line to the other, I believe it will be better, for the reaſons I ſhall give. To diſpoſe them otherwiſe, ſo as to form a ſaliant angle by two branches, equal to the others, at every 400 fathoms, which ſaliant angle muſt be flanked by two redans, and that each extremity be terminated by a baſtion.

I would fix the middle of the gorge of the baſtion 20 fathoms from the point where the extremity of the branch falls on the line; its flanks I would elevate the ſame way, and of the ſame ſize as the flanks of the redans; then draw a line from one ſhoulder to the other, on the middle of which line elevate a perpendicular equal to one of theſe parts,

and

and the extremity will be the point of the flanked angle, which thus will always be a right one.

The advantage I here propose, is to draw from the flanks of the bastion the same fire from small arms, as from the others, and from the face, where I propose artillery, a fire which crossing in front, should serve as the first defence to the line.

Hence, the fires of the four adjacent flanks cross before the middle of the 400 fathoms, that is before the part farthest from the bastions, and consequently from the artillery, and has the most occasion for this assistance.

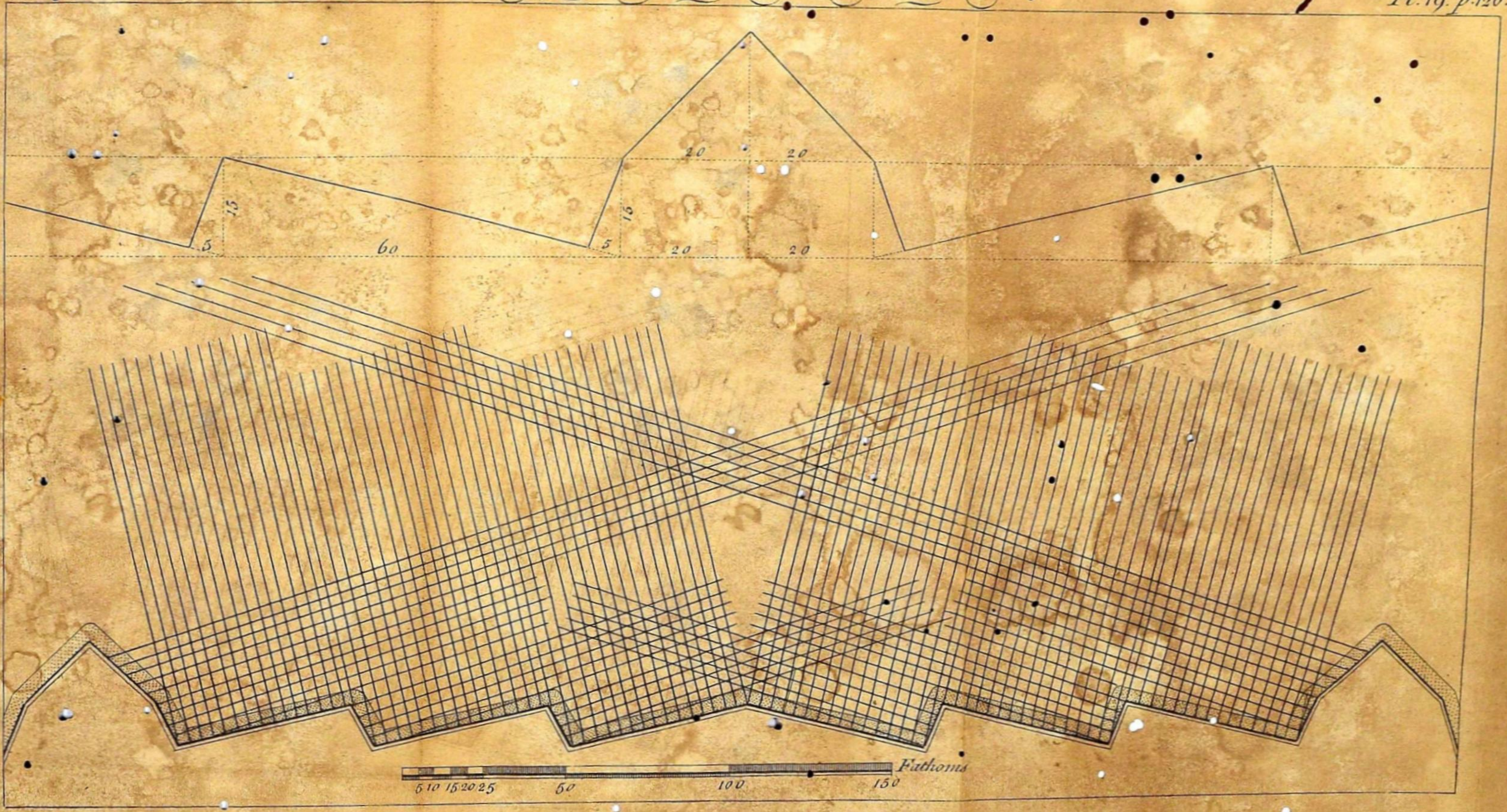
Tho' the faces of these bastions are seen less obliquely from the curtain, than those of the redans of the common method, I allow they are the most defective parts; but besides their batteries which render them respectable, if we would not make the angle too acute, for fear of making them too long, we may render their access very difficult by pallisades, felling, or by breaking the ground in holes or wells.

Supposing the line entirely indented, as we did in the beginning of this article, the extent of parapet does not exceed a right line, but by about 11 fathoms 2 feet in 60 fathoms, which is not a fifth; but if we follow this plan entirely, it will exceed between 84 and 85 fathoms in the front of 400.

I own these lines please me much, were it only because the repetition of the flanks,

by

INDENTED LINES



by their proximity, double the defence, and render it more effectual. But must further observe, that the artillery being, by its position, out of the line, it may if necessary graze it, or very nearly; an advantage which none of the beforementioned methods have.

There are circumstances where works are inclosed in the line, to favour the rallying of the troops, if needful: to effect this, it is sufficient to detach the bastions, and intrench them at the gorge, but they must be constructed with a strong profile, and surrounded with pallisades, or wells sunk in the ground.

V. What M. *Folard* proposes in his excellent commentaries on *Polybius*, may give an idea of a quite different construction to the preceding one, tho' the intent of the author was only to strengthen his fortifications by an augmentation of works. "It must be "observed, says he, above all things to make "advanced redouts, or arrows, at every 30 "or 40 fathoms, and their communications "ought to be between two banks or para-"pets, well pallisaded on all sides, and so, "that four men may march a-breast, or in "front, between the two banquets."

It could be wished, that so learned an author had entered into a greater detail on this subject, or at least had given a plan of his scheme; but all that can be concluded from thence with certainty is, that he supposes lines with redans traced in the common manner; and from thence we may judge

 of

of the advantages and disadvantages of his scheme.

Pla. XX. Fig. 1. We must then suppose a lunette advanced 30 or 40 fathoms before the curtain of one of these fronts; for it is before the curtain he places them: what is the consequence? that all, or nearly all the fire of the adjacent flanks, enfilades the gorge, or fires obliquely on the faces. I here suppose, that this distance of 30 or 40 fathoms is taken from the gorge, and not from the flanked angle of the work, or else the lunette, scarcely projecting beyond the saliant angles, would not have the intended use.

Pla. XX. Fig. 2. With regard to the common method, if redans are so obtuse, that the lunettes may be defended and not battered, from whence are these redans and the curtain to be flanked?

It is true, the communications fire upon the whole faces of the adjacent redans, in either case; and if such works are made before all the fronts, the rest of the fire will defend the ground, before the communications next to them: this fire is certainly more dangerous to the enemy than to the defenders; yet nothing is more incommodious than to be exposed to it.

It may therefore, I believe, be concluded, that these lunettes, tho' good in themselves, cannot possibly be used with lines traced after the common method.

Permit me to make one digression, it shall be short, and the example of the author I quoted

quoted authorizes me. An officer who can talk well of war in general, if he is not an engineer, has not the ſame force of argument, when he comes to touch on any part of fortification; which equally confirms me in what I have before quoted, *viz.* that it is very dangerous to advance any thing on theſe ſubjects, that we have not proved by ſcale and compaſs; and that it is only from the body of engineers itſelf, that we muſt expect any inſtructions.

But to return to the lunettes. I think all the effect we may expect from theſe pieces, and eſpecially from their communications, ſo proper to command in the rear, may be obtained, by finding a method of uſing them without any inconvenience.

VI. The whole then conſiſts in flanking their faces, and directing theſe different fires, ſo that they may not be hurtful to the other parts.

Theſe faces have no other protection to afford each other, than a fire greatly advanced before them: they are at too great a diſtance from each other to obtain a grazing defence, therefore it is not from thence we muſt expect what we ſeek for.

One line only, whatever inclination we may give it, cannot flank the lunette and the intrenchment: were we not convinced of the dangers, and ſmall effect of defences badly directed, or very oblique, we could not deny that the directions of theſe fires are too Pla. XX. Fig. 3.

ſcattering to part from one and the ſame point.

Since then one flank alone is not ſufficient, let us endeavour to obtain two. Cut the front (ſuppoſed of 120 fathoms) into two equal parts by a perpendicular; give 35 fathoms to the brake of the branches; 18 to the demi-gorge of the redan, and 25 to the capital: to conſtruct the lunettes, ſet off 60 fathoms, on the perpendicular produced beyond its interſection with the front line; draw the faces of 25 fathoms long, and ſo as when produced meet the branches within 20 fathoms from their ſaliant angles.

The capital of the lunette will thus be cut by the line of fire, at a little more than three fathoms from the flanked angle; ſo that this piece will be defended on each ſide by 20 fathoms, and the branch of the intrenchment by 22 fathoms, of a fire almoſt grazing, which is all that can be deſired.

There remains only the communication to trace; and it certainly is not the moſt eaſy part. The enemy cannot there be well diſcovered but in front, by a part equal to its breadth: beſides, if it is raiſed too much, it is evident it will maſk the fire of the branches, and if it is ſunk, it will not command enough, and be plunged into from the ground without.

To guard as much as poſſible from theſe inconveniencies, I give only 15 feet for the paſſage at the gorge of the lunette, and increaſe

creafe it to 30 where it meets the front line.

By this obliquity I hinder the fire from grazing too near the faliant angles of the retrenchment, and have the advantage of oppofing an enemy, when entered by the oppofite extremity, with a front more than double theirs; but as it is an angle, and confequently cannot afford all the fire neceffary, I would raife a traverfe floped in a *glacis*, at the beginning of the communication, and make little branches on each fide parallel to thofe of the redan, as may be feen in the plan.

As to the elevation, I would raife the top 3 feet from the ground, and fink the infide 16 inches, that is juft as much as neceffary to give the parapet a proper height; the fummit muft be flat, without bent or flope, that the fire may horizontally graze the country.

Two different motives make me here reject banquets; one is, that as we cannot give them lefs than four feet in breadth, including the flope, the communication would by this means be widened 8 feet, and confequently more expofed to the fire in the rear; the other, that the lefs the communication is covered, the more it will be plunged into from the branches of the intrenchment.

It is impoffible to hinder two lines, parallel to each other, from battering one another at right angles; therefore one commu-

nication always fires on the next, and I know no other remedy for it, but to place lunettes at every other front only. Theſe flanks would then ceaſe to be hurtful to each other, and would protect the intermediate front by a reverſe fire, which may be ſhortened ſome fathoms, if we would have it better defended.

VII. Theſe kind of lines is already complicated enough, yet when we have more time than neceſſary for the eſſential diſpoſitions, and the troops are not fatigued with ſervice, it may be prudence in a general to ſeek means of prolonging their employment; beſides the real uſe he would draw from this for the ſecurity of the camp, it is well known, that it is the moſt agreeable method of preventing deſertion, ſickneſs, and all the diſorders, which idleneſs expoſes a ſoldier to: ſo important a ſubject requires our moſt ſerious attention.

Tho' theſe ſchemes, ſpeculative as they appear, ſhould be difficult to put in practice; or they ſhould have faults equal to thoſe of the common method, or even more eſſential, it will be always neceſſary to mention them, to give them their full career, if I may be allowed the expreſſion, and to ſhew what variety a ſubject, hitherto treated in ſo plain and uniform a manner, is ſuſceptible of. I would therefore propoſe the enlargment of the work in view, tho' it were as conſiderable as it is otherwiſe.

The figure being traced as before, excepting the redan, which is here left out, draw a line of defence from the flanked angle of one of theſe branches, to a point on the other, 45 fathoms from that branch; from a point, twenty fathoms on its extremity, let fall a line perpendicular to the other line, which will be the flank; this point at 20 fathoms alſo ſerves for the direction of the faces of the lunette. Plate XX. Fig. 4.

This alteration is but trifling in itſelf, ſince it is no more than a brake of 25 fathoms baſe, but it produces a very great one in reſpect to the fires: according to the firſt plan, thoſe of the branches croſs all on the rentring angle, they cover it entirely with a parallel fire, and are croſſed by that of the redan; but we are obliged to leave one ſpace vacant, that would batter the lunette. According to the other, a different direction is given to a conſiderable part of the fire which is directed towards the flanked angle: for the fires of the new brake, the one part cutting the capital of the ſame branch, and the other grazing the oppoſite ſaliant, croſs with the other defences.

We here employ all that ſpace, which for fear of firing on the lunette, we were obliged to leave vacant in the firſt plan: this circumſtance, and that eſpecially of the two additional columns of fire, which cover the ſaliants, ſhould recommend this plan, as well for uſing lunettes, as for forming a plain intrenchment.

 But

But this does not prevent us, even in the caſe we are ſpeaking of, from making good uſe of the other. We ſhould, as I obſerved, only place theſe advanced works in every other front, and the intermediate front will be very well traced after this plan. The large columns of fire which cover the rentrant, ſerve as a lunette for the ſecurity of it; the ſaliant angles will be well defended, ſince being common to the adjacent fronts, they will be croſſed by four columns of fire.

It appears then by the broken *tenailles*, and by the double and treble flank, that this branch of military architecture, is as capable of producing as ſtrong fortifications as that of places.

Observations on the ſeventh chapter.

The various methods of conſtructing retrenchments, according to the different ſituations and circumſtances, is the ſubject of this chapter. The author endeavours with candor to diſcover the advantages and diſadvantages attending ſome ſorts of works, not even ſparing his own miſtakes: the figures in plate 18, are inſtances of his impartiality; theſe were works he intended to make, being in a hurry, and not having ſufficient time to conſider their forms, and which, he ſays, had they been executed, would have fallen into all the defects of the common conſtruction. It happens very ſeldom that an engineer has time

time to make a deſign of his project; without which, the author is of opinion, defects can hardly be avoided; not conſidering that ſomething more is required than what can be learned by practice. It is true that, in order to conceive a true idea of lines variouſly conſtructed, they ſhould be traced on paper, and examined at leiſure, either in winter quarters, or when nothing elſe is to be done in the field: but when an engineer is once upon a ſpot of ground to be fortified immediately, he ſhould at firſt ſight, without heſitation, know how to trace the different parts, ſo as to make the beſt defence that the circumſtances will allow.

The author, with very little reflection, might eaſily have ſeen, without tracing the works on paper, that by making lunettes before the rentring angles, cloſe to the ditch, whoſe faces being perpendicular to the branches; theſe very lines, imperfect as they now appear, would then have had all the defence he could have deſired, and have taken up the high ground between the line and the river. Pl.XVIII.

After having ſhewn the little defence theſe lines are capable of, he gives ſome in plate 19, which are of a more perfect conſtruction; their ſides are indented, and form a ſaliant angle in the middle, with baſtions at the angles of the polygon. It is certain, that the middle part of the front is ſtrongly defended, but the baſtions have no defence that

that I can find; and as the enemy will make their approaches in the capitals of the baſtions, as being the weakeſt part, and not in the middle of the front, as the author ſuppoſes, all this great defence is of no conſequence. It is ſomething ſtrange, that the author ſhould neglect the moſt eſſential maxim in fortification, *viz.* to make all parts equally ſtrong, and on which the true art of fortifying irregular places intirely depends. It is true, he ſeems to be ſenſible of this defect, and pretends to remedy it, by placing artillery upon the faces of the baſtions, and felling trees, or making pits with ſtakes in them; but ſuch trifling obſtacles as theſe are ſoon removed, unleſs they are ſupported by a ſtrong fire, which is not the caſe here; nor can the artillery be of any uſe, excepting it was placed upon the adjoining parts of the branches, where indeed it might flank the baſtions, tho' very obliquely; but after all that can be done to remedy theſe defects, this conſtruction is, in my opinion, not ſo advantageous as thoſe mark'd fig. 2. and 3. in Plate 17. altho' the work is greater, and the conſtruction more intricate.

In plate 20, are different conſtructions of retrenchments, of which the firſt and ſecond are imitations of M. *Folard*, which our author thinks are not ſo well explained, as ſo able a writer might have done; and therefore he ſuppoſes the common conſtruction as to the lines themſelves; but in regard

to

to the lunettes, they could not well be nearer the curtains than he has placed them, becauſe they would not elſe anſwer the ends propoſed, as projecting but very little before the other works: and if they are placed in this manner, the fire of the adjacent flanks will enfilade their gorges, and defend the faces but obliquely.

It is not ſo much the ſituation an author chuſes to place a work in that is to be conſidered, as that which the figure or nature of the ground requires: and therefore theſe lunettes ſhould, in my opinion, be placed ſo near the curtains, as to defend the faces nearly directly, and ſo conſtructed, as to be reciprocally defended by theſe faces: in this caſe the works would be as ſtrong as their nature will admit of: as to the lunettes not projecting before the other works, it is rather an advantage than otherwiſe; ſince the defence of a work weakens in proportion as it projects beyond the reſt; and it is always at the moſt ſaliant part where the enemy makes his approaches. This however ſuppoſes the ground to be every where even, or upon a level; but when a riſing ground happens to be before a part of the line, that might be an advantage to the enemy, either by making his approaches there under cover, or if he ſhould get poſſeſſion of it, to raiſe a battery, or a fort to annoy the trenches: it is then of the utmoſt importance to raiſe a good detached work there, and to make a

ſecure communication from it to the line. The author makes a digreſſion as to the abilities of officers, in reſpect to engineering; where he ſays, tho' an officer writes ever ſo well upon the different parts of the art of war, which he had an opportunity to know by experience; yet when he comes to treat upon fortification, what he ſays cannot always be depended upon; which is as much as to ſay, that engineers only are qualified to write upon fortification. But tho' an officer may perhaps not be ſo well acquainted with all the minute particulars; however, as it is his duty to underſtand how works are to be defended, and how to intrench himſelf upon particular occaſions, if he is otherwiſe qualified, he may write upon that part as well as an engineer.

The third fig. in plate 20, repreſents the ſame work as the ſecond figure in plate 17, with this difference only, of having a lunette before the redan; but for what reaſon he places this lunette ſo far from the redan is not eaſy to be gueſs'd: for if their faces were only about five or ſix fathoms from thoſe of the redans, and perpendicular to the branches which form the ſaliant angle of the line, they would defend theſe branches, and reciprocally the branches would defend their faces, each other at right angles, which is the greateſt advantage they poſſibly can have, according to the conſtant maxim of fortification. I ſuppoſe the author thought, that

if

if the lunettes were placed ſo near, they might prevent the faces of the redans from defending the branches: this is certain they would; but as the defence of the faces of theſe lunettes is at right angles, it is no more than to change an oblique fire for a direct one: beſides the lunettes being ſo near, they could not be taken, as being ſtrongly defended by the redan, and the enemy would be reduced to attack the ſaliant angles of the line, which being defended by a direct fire, would make all the reſiſtance that is poſſible. Beſides all the difficulties of making the communications, which the author imagines to be none of the leaſt, would be entirely avoided.

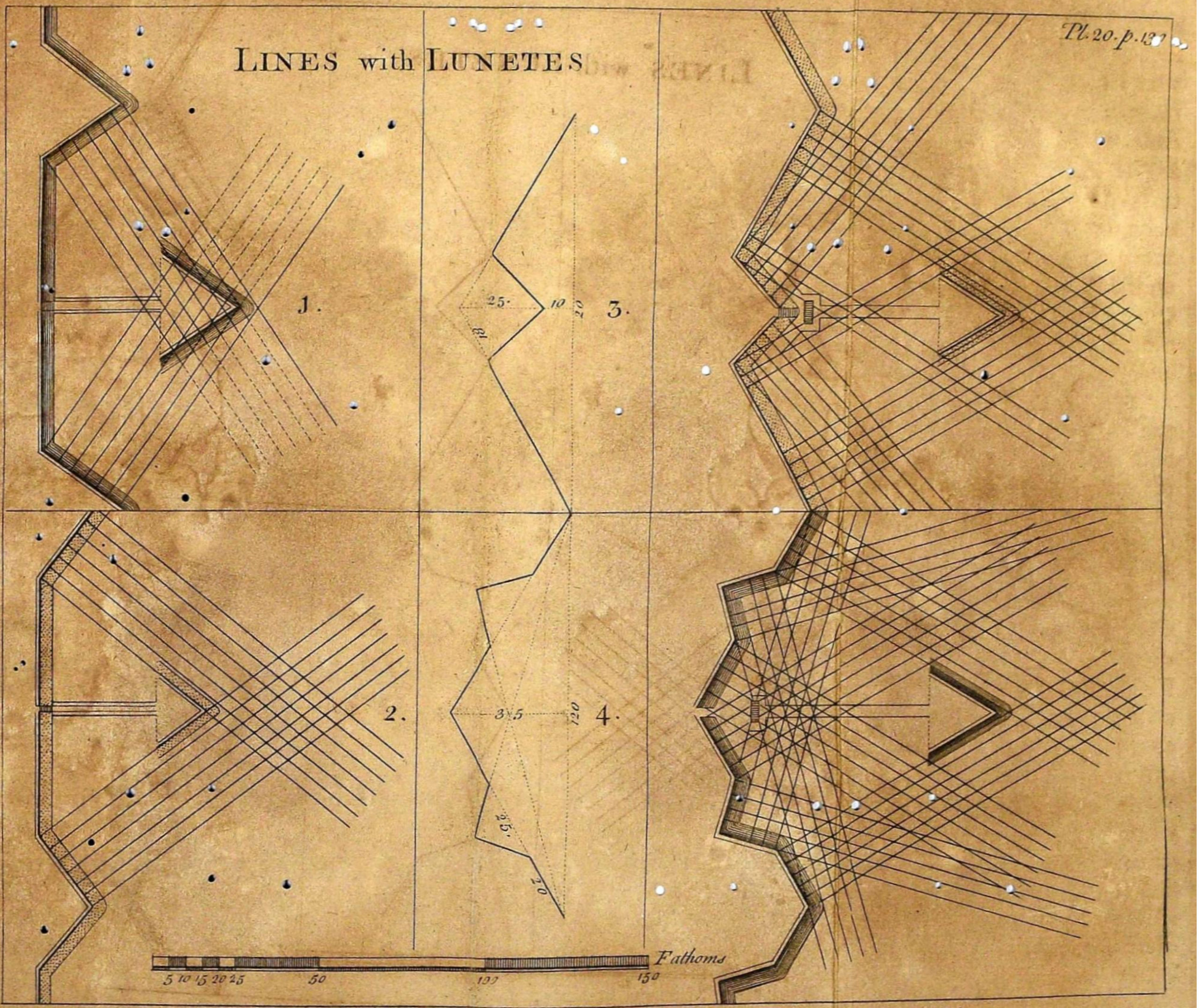
The author propoſes to make an additional flank by the broken curtain, as may be ſeen in figure 4, plate 20; but tho' this produces an additional fire to the defence of the baſtions; it is however but very inconſiderable, ſince it reaches their capitals but at a great diſtance, and obliges the lunettes to be placed too far from the curtain, which, in my opinion, is a conſiderable defect; for as their faces protect the capitals of the baſtions but very little, and at a diſtance, the enemy, by attacking theſe capitals, after paſſing the faces of the lunettes, may take them by the gorge with all the troops in them, with very little trouble, notwithſtanding the defence of the communication, which can be no more than one diſcharge of ſmall arms,

arms. To render this conſtruction as perfect as could be wiſhed, I would make that part which forms the rentring angle of the curtain in a right line, and place the lunettes cloſe to it, and make their faces at right angles to the faces of the baſtions produced; or if the ſaliant angle of the lunettes ſhould become too acute, to make it ſomething more open: by this correction all the works would defend each other, nearly at right angles, which is all that can be deſired, and the labour of making them would alſo be leſſened.

When every eſſential precaution to ſecure the camp has been taken, ſays our author, and time as well as leiſure permits, it may often be prudent for a general to employ the troops in ſome work or other, merely for the ſake of preventing idleneſs, as being the mother of all evil: but as all uſeleſs works are ſuperfluous, and to fatigue the troops without neceſſity is an idle notion, it would be more conſiſtent with reaſon to add ſuch work, as might ſtill more ſtrengthen the camp at a time of leiſure: ſuch, for example, as a ſecond ditch, and to fill the interval with pits, having ſtakes drove in them, eſpecially before the ſaliant angles, or where the enemy might attack and penetrate with more facility than any where elſe. Beſides, many other works might be made, ſo as to be a further ſecurity; and the ſoldiers would not think their labour loſt, if

they

LINES with LUNETES



they were convinced that it tended to their own preſervation.

CHAPTER THE EIGHTH.

I. *Lines with baſtions after the common method; their defects.* II. *A new and more perfect method.* III. *Schemes of lines with detached baſtions.* IV. *With detached works.* V. *Lines detached in parts.* VI. *Works to be made for a day of battle.* VII. *Example of their uſe at the battle of* Fontenoy. VIII. *Lines joined to works cloſed at their gorge.*

I. THE inſufficiency of redans for the defence of a line happens, as we have ſhewn, from the great obliquity of their faces: ſuppoſing the curtains ſtraight, we cannot remedy this but by flanks, and to add flanks to theſe pieces is actually making baſtions.

We gain by this an additional fire of the flanks, for that of the faces croſſing in front, ſerves inſtead of, and exceeds that of the redans; it is true, the extent of the figure produces this advantage in one reſpect, the reſt depends on the curtain, which is not weakened by it, as it is ſhortened in proportion.

This made me reſolve to baſtion the intrenched camp at *Ruſſenheim*, and that of *Spire*. I ſhould have ventured this novelty with much more aſſurance, had I known myſelf ſup-

supported by ſuch an authority as the *Marquis de Santa Cruz*, but his book had not then appeared in *France*. "To flank an intrenchment, ſays he, ſpeaking of that of an army, "I would not confine myſelf to ſaliant angles, whoſe defences are obtained under "very obtuſe angles, by which the defendants are greatly troubled: but I would "form baſtions.

Theſe kind of lines is without doubt better, and at the ſame time more beautiful than that with redans, ſuppoſing, however, that there are other real beauties than what are uſeful. We may then wonder that they were neglected, even to appear unknown, before the ſiege of *Philipſbourg*; they were the firſt and only of that kind that I had ſeen.

Pl. XXI. Fig. 1. I traced one part of them which had 130 fathoms front, 25 perpendicular, and 35 for the faces, the flanks were perpendicular to the lines of defence.

Being acquainted only with theſe, I ſhall give no others for examples; and as my ſubject has obliged me rigorouſly to examine the common conſtruction of redans, I cannot, diſpenſe doing the ſame here.

Theſe conſtructions have this in common, that the curtain is covered by ſo much fire, as to become in ſome manner inacceſſible: this apparent advantage is no defect in itſelf, but it neceſſarily produces one. The fire a front can furniſh, being always proportionable

able to its extent, if we direct too much towards one part, another muſt want it: our greateſt care therefore ſhould be to diſtribute it equally throughout, having regard to where there may be the greateſt occaſion of it; but that is not done here; the curtain, the moſt rentring part, of courſe the ſtrongeſt in itſelf, reaps almoſt all this defence; and the parts moſt ſaliant, and conſequently the weakeſt, that is the faces, have none at a diſtance from the angles, and are not flanked, but very near, and for a ſmall breadth.

I don't know that hitherto theſe defects have been much regarded, perhaps they have been thought inevitable, as being nearly the ſame as thoſe of common lines; let this be as it will they do not appear leſs important than thoſe we have already mentioned.

The firſt objection is, that the ditch being parallel throughout to the principal line, the counterſcarp muſt hide one part, ſo that the enemy in the ditch cannot be diſcovered from the oppoſite flank. I have before mentioned this inconvenience.

The ſecond, not quite ſo obvious, was made to me by *M. de Cormontaigne*, an engineer of great abilities and reputation; it is, that the enemy, maſters of a baſtion, but yet too weak to march forward, will be diſlodged, or driven back, with great difficulty; for having their flanks covered by thoſe of the work, they can only be attacked in front, and by a leſs front in proportion to

their's and the number of their troops, than in a redan; becauſe of the ſmallneſs of the redans and the great obliquity of their faces. I ſhall examine this obſervation with all the care and attention it deſerves.

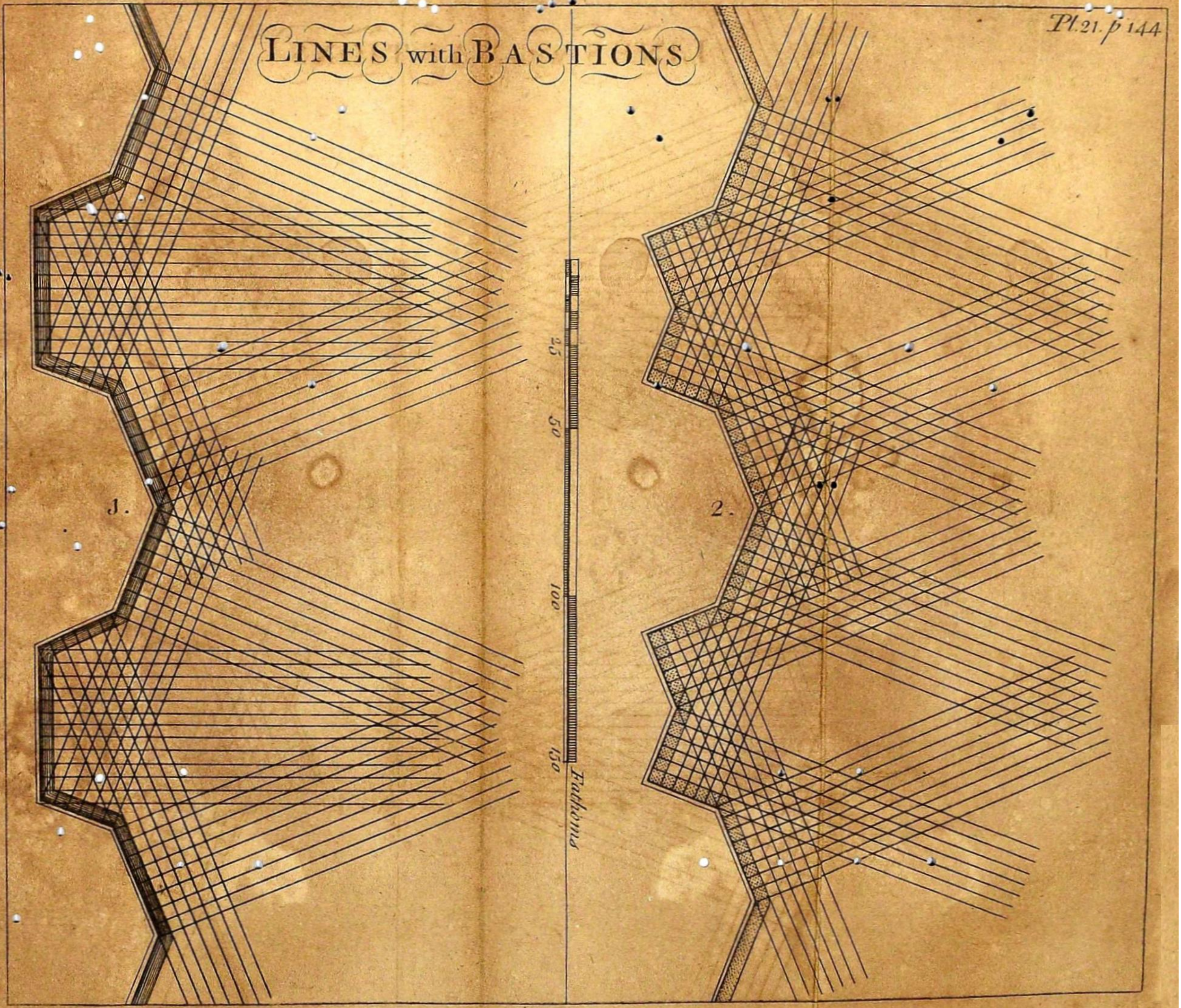
II. The greateſt defects of theſe lines, being nearly of the ſame kind as thoſe of the common method, we may remedy them by almoſt the ſame means.

Pl. XXI. Fig. 2. I always ſuppoſe the front 120 fathoms. Give one fifth to the perpendicular; make the faces half the lines of defence; included by their interſection and the flanked angles; let fall the flanks ſquare on this line, and thus form a broken curtain.

The figure ſhews that we thus gain two additional columns of fire on the capitals, and that there is more left for the curtain than it can want for its defence.

As to the cover which we find in part of the ditch of the faces, towards the angle of the ſhoulder, I know, no other remedy than what I recommend for the intrenched camp of *Spire*, and luckily that is ſufficient. The hurtful part of the counterſcarp muſt therefore be taken away to about three feet from the bottom: for example, if the ditch be ſeven feet deep, the ſide is ſloped for four feet, in form of a *glacis*, which muſt be ſo directed as to be grazed by a line drawn from the ſummit of the parapet, to the point where the ſlope begins.

The


LINES with BASTIONS
1.
2.
25
50
100
150
Fathoms

The first difficulties being got over, I pass to the last. The redan and the bastion supposed closed at the Gorge, reckoning from the principal line, the first contains 330 square fathoms, and the bastion 1770½: one of the gorges is 30 fathoms wide and the other 76½.

Therefore to attack the enemy with equal advantage we must occupy a front more than five times larger before the bastion than before the redan, in regard to the number of troops they can contain; but as we must only consider the extent of their front rank, this is reduced to little more than twice and a half.

I think we may compare these fronts in the following manner. Form a right angle triangle without, on the gorge of the work; on each of the small sides, at their extremities joining the *hypothenuse*, elevate a perpendicular 60 fathoms long, from the middle of the gorge, and with this radius describe an arc of circle, and the fronts will be formed by chords. Pl. XXIII. Fig. 2.

I suppose all the fire contained in this part of the circumference, because the obliquity of the shot beyond these extremities would not sufficiently enter the work.

We shall then find in the redan five fronts, which may be advantageously placed in that space; one that is equal to the gorge, two equal to the small sides of the right angles

 triangle,

triangle, and two others larger than these, and smaller than the first.

The bastion affords but three, one equal to the gorge, and two equal to the small sides of the triangle.

Without recourse to calculations, when superfluous, it is evident by the figure, that the fronts which can be disposed against the gorge of the bastion, are not near double in length to the sum of the others; for if we compare the arcs of the circle, we shall find that one is more than 133 fathoms, and the other only about 206. Lastly the radii of these arcs, that is, the distance from the point from whence I suppose the fire to come to the middle of the gorge, will be between 71 and 72 fathoms in the redan, and 91 in the bastion; another disadvantage in this last construction.

The observation must then be acknowledged just, and if we come to close with the enemy, it is easy to force them from the redan, being drawn up in form of a reversed coin; but after all, the gorge of the bastion is but 77 fathoms, and the total of the fronts, which batter it at right angles, is more than 184; therefore there is no equality between the assailants and defendants; and tho' I agree to this inconveniency, I doubt if the engineer who discovered it, thought it considerable enough to reject a method, otherwise so advantageous.

III. In 1743, neceſſity obliged me to invent a kind of lines which I think uſeful in certain caſes; viz. when we are to turn a ſmall river, or can fill the ditch with water. It was at the camp under *Landau*. *Marechal de Noailles* ordered me, when I was leaſt prepared for it, to trace an intrenchment from the mill of *Oſſembach* to below the village of *Offerſheim*; it was near 2400 fathoms: this work was ordered to be begun by break of day, it was then almoſt night, and I half a league from the place. I did not know where to find piquets, nor any one to help me, and the workmen were to begin at the break of day: if, according to the ſaying of a great man, that the word *impoſſible* ſhould be left out of the dictionary, it ſhould be eraſed out of the *ſoldier's dictionary*; it is a mortifying word to make uſe of: the thing did not yet appear practicable to me. I therefore propoſed to trace it in a right line, with ſome ſaliant angles at a diſtance from each other, intending to flank it by ſome detached works, when more at leiſure.

An engineer has great reaſon to be ſatiſfied with his orders, when the general who gives them is himſelf an engineer, and does not diſdain to enter with him into the moſt minute detail. I pointed out the impoſſibility, which he was not ignorant of, and the expedient which had ſtruck me; he underſtood me with half a word, and conceived, even before I had explained myſelf, the ad- Pl. XXII. Fig. 2.

 vantage

vantage of having a parapet and a river before one, when we have not a moment to loſe in intrenching ourſelves, and that the works with flanks that I propoſed, furniſhed four columns of fire, inſtead of two, and being ſeparated from the intrenchment by a ditch full of water, if the enemy took it they were not much more advanced, ſince they could not keep there; and in ſhort that nothing was more advantageous, than to have artillery placed in ſuch works as projected beyond the line.

The day was quite ſpent when I arrived at the place, and the fires I had lighted to ſhew the line were confounded with thoſe of the camp, and to add to my misfortunes I had a fever: I was therefore ſoon obliged to give over; but at 9 next day the line was traced: in ſhort, being worſe than the day before, I had great occaſion for ſo good an aſſiſtant as *M. de St. Paul*, and was alſo much obliged to *Le Chevalier de Beauſobre*, at preſent colonel of the *Huſſars*.

This work begun the ſame day, was finiſhed before I had traced the detached pieces becauſe I was otherwiſe employed: and as it was thought that nothing more was to be done than what appeared, this long line without flanks was ridiculed with ſome appearance of reaſon; and the motion of prince *Charles* of *Lorrain*, having obliged us in the mean time to ſend a conſiderable detachment towards the higher *Rhine*, and to retire with

with the reſt of our troops behind the *Moutre*, I doubt if this piece of work gained me any credit with moſt officers of the army.

We find the baſtion here have not the inconveniency I have ſpoken of in the preceding article (for theſe lunettes with flanks are in effect detached baſtions) ſince the enemy cannot keep there till he has done, that is, till he has forced the line: but this method is not good, when the ditch is not full of water.

IV. I practiſed another occaſional method of fortifying, much more expeditious, at the ſame camp, from *Queichem* to the mill of *Offembach*.

This method has the advantage of the other, being practicable in dry or wet ground, it conſiſts in covering the front of the line with detached works, turned ſo as reciprocally to defend each other, or thoſe which may afterwards be added in their intervals.

When we are likely to be diſtreſſed for time or workmen, the diſtance from the middle of one of theſe works to that of the next may be 240 fathoms. If attacked in this ſtate, the enemy cannot break thro' the intervals, without firſt taking theſe pieces, or being flanked.

If we have time, the intermediate pieces are conſtructed, and the line is then defended in the ſame manner as the fore-mentioned ſcheme for *Pilſting*, or what was practiſed in the plain of *Deckendorf*. We may

also observe, that in this case we are exempt from one of the great defects of lines in general, which is, that we cannot sally from them but by a small front: but as it is necessary, especially when inferior in number, to guard these great intervals, nothing prevents our closing the whole afterwards, by straight or broken curtains.

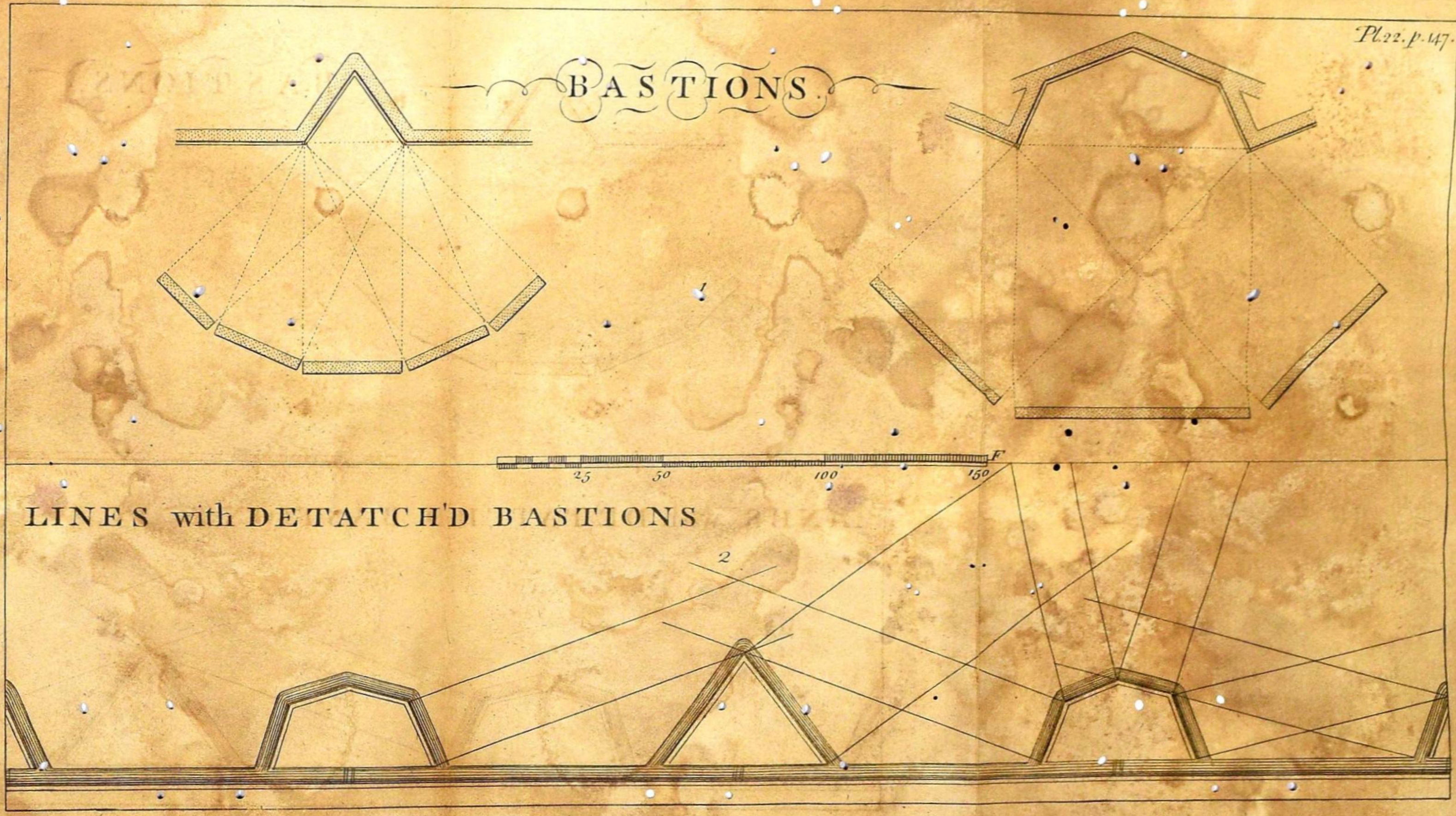
Great care must be taken in tracing these lines, piece by piece, lest we should batter the work which is to follow, instead of flanking it.

V. Those lines which are formed of detached works, tho' they may be esteemd as of this kind, are traced in a very different manner Such were those according to the history of *M. de Turenne*, which were raised by general *Merci* in 1645, for the battle of *Nordlingue*; each piece was composed of a redan, placed in the middle of two common demi-curtains, whose extremities were terminated by a hook.

As I only quote this from the plate, which had no scale, I do not know what were the proportions; but changing the figure a little, I would recommend the following construction.

Pl.XXIII. Fig. 2. Draw lines 100 fathoms long, and 100 fathoms from each other. At the middle of each line trace a redan of 30 fathoms gorge and 24 capital. At the extremities of these lines erect perpendiculars of 20 fathoms, for the brake of the branches; from the foot of the perpendicular to the summit of that of the

next


Pl.22. p.147.
BASTIONS.
1
25
50
100
150
F
LINES with DETATCH'D BASTIONS
2

next front, draw the line of defence, on which lay 6 fathoms for the direction of the hook.

Theſe intervals are covered by 4 columns of croſs'd fire, on which account I make them no larger: the greateſt part of the branches have 3, without reckoning the direct fire, and the faces of the redans are flanked nearly at right angles by the whole length of the branches; advantages which the intrenchments of general *Merci* had not, as the demi-curtain formed a right line.

As to cannon, they may be placed in the angles of the redans, or if we chuſe only to uſe ſmall arms in theſe works we may place them in the intervals, as general *Merci* did.

In ſhort, intrenchments, detached in parts, may be fortified after many different ways. All are good, in porportion as the intervals are, and each particular part, is more or leſs defended.

VI. This ſubject naturally leads me, to ſpeak of another kind of fortification, which does not differ much from this, tho' we cannot properly give it the name of lines. Excepting the laſt, whoſe uſe is more doubtful, all the lines treated of, either ſuppoſe, that we ſeek to avoid an action, or are not willing to loſe the advantages gained by them; but their uſes in regard to battles, are not confined to the defenſive alone.

When a general, more than equal in forces, or reſolved to riſk an engagement, advances to a camp which he has reconnoitred, to

ſtop

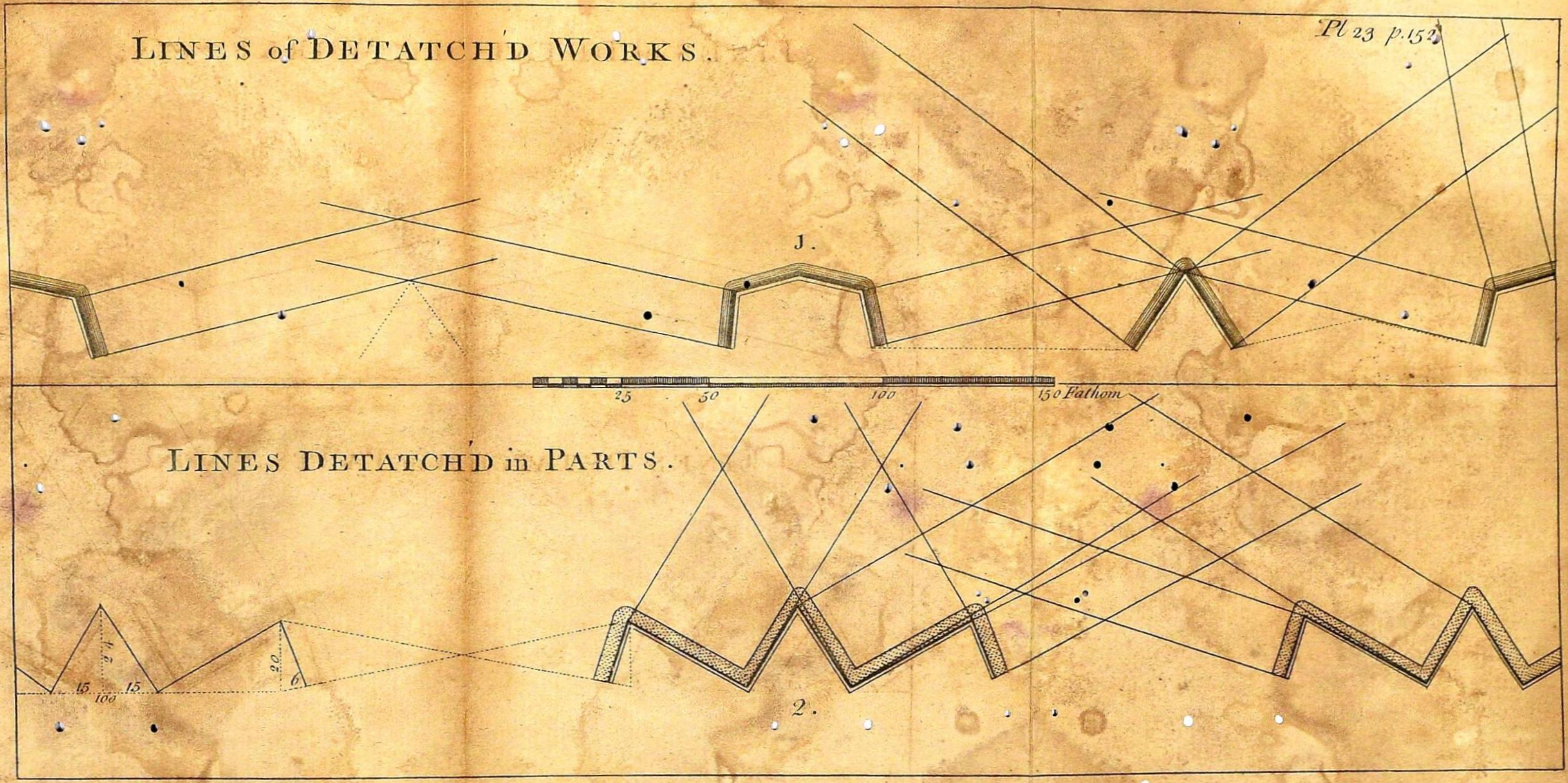
ſtop an enemy; or by drawing nearer to them, will oblige them by his poſition to attack him; will not attempt to intrench his camp at the moment almoſt of the action, and to begin works which probably he would not have time to finiſh; he would not beſides encloſe himſelf, and put it equally out of his power to attack, purſue, and reap all the advantages of a victory; but will ſeek to ſecure himſelf by thoſe precautions which often decide it; precautions eaſy, of little work, and which in no manner obſtruct the neceſſary motions.

Theſe precautions commonly conſiſt, eſpecially if weak, in cavalry, or the wings are not ſufficiently ſupported, in ſecuring the flanks by felling, or *Chevaux de Friſe*, in deepening ditches with upright banks, in ruining bridges, in deſtroying fords, and in ſhort, to render them every where as inacceſſible as poſſible.

When there are villages, or ſome great building towards their extremities, they muſt be put into a ſtate of defence without loſs of time; the ſame uſe is made of them which are but at a ſmall diſtance before the line, eſteeming them as fixed points and flanks. In ſhort, if we have leiſure large redouts are conſtructed, if not on all the front, and ſo as their fires may croſs, at leaſt in the weakeſt places, or from whence the artillery can be moſt advantageouſly ſerved.

It is uſeleſs to add more, for as all depends on circumſtances, nothing poſitive can be

ſaid;


LINES of DETATCH'D WORKS.
1.
25
50
100
150 Fathom
LINES DETATCH'D in PARTS.
15
15
100
20
6
2.

ſaid; and ſpeaking in general would only be unneceſſarily repeating what I have ſaid in 7th article of 4th chapter.

VII. I cannot give an example of theſe precautions, more known, or more convincing, than that of the battle of *Fontenoy*: but as it is foreign to my ſubject to give a detail of the engagement, I ſhall confine myſelf to what concerns it, by the wiſe diſpoſitions of a general, who all *Europe* confeſſes, juſtified in the beginning of that war, what a celebrated writer had predicted of him (*a*). Pl. XXIV.

The right of our army being ſupported by *Antoin*, and conſequently by the inundation of the *Scheld*, it was neceſſary for greater ſecurity to intrench the village, which was done in the night, by the troops that guarded it.

From *Antoin* to *Fontenoy*, another village intrenched with great care, and which was the centre, is 800 fathoms. This front was covered by three redouts, the firſt on the ſide of *Fontenoy*, the ſecond 100 fathoms from the firſt, and the third 140 fathoms from the ſecond, they were conſtructed, or rather roughly thrown up, the ſame night. The want of time, in all appearance hindering their increaſe, the fortification of the centre was principally attended to, which was the most

(*a*) M. *Folard*, ſpeaking of the method of firing which M. *Saxe* had introduced into his regiment, "a method (ſays he) "that I admire, as much as its inventor, whoſe genius is one "of the greateſt military one's I know; and we ſhall find in "the firſt war that we are engaged, that I am not miſtaken in "what I think". Book II. Chapter 14th.

most essential, because the rest was flanked by the village of *Antoin*, which commanded almost all the breadth.

The left, squaring with the front, extended to the woods of *Barri*, joining to the village of *Ramecroix*; we had felled the wood at that place, and posted the regiment of *Grassin* in it, to observe what passed there.

It is plain we did not find this wing so easy to support as the right; but the wood, crowded as it was with infantry, the felling which covered the edge and two redouts, which were raised there, supplied this so well, that the brigades which formed it, served in the heat of the action as a reserve to the centre.

I need no other proof of the necessity of these works, than the obstinate bravery, with which the *English* attempted to force *Fontenoy*, despairing to break through elsewhere. This post, by the best accounts I have seen of the action, was a capital point, and of greater consequence to us to defend it, least the enemy, once masters of it, would have maintained themselves in it, and have cut our army in two.

I have nothing more to add on this battle, but the steadiness of our troops; for works so imperfect, could not be supported against so vigorous an attack, without great resolution. Yet all the fire of the village and the redouts, could not prevent the enemy from penetrating between both; a bold courageous attempt,

attempt, and which ſeemed once to have given them the victory, but which at length, by a prudent motion on our ſide, was turned in favour of us.

VIII. The importance of theſe articles, and their connection with the preceding, will favour the digreſſion in the laſt: but to return to our ſubject.

It has for ſome time paſt been ſtrongly debated, whether or not it be proper to join works cloſed at their gorge to lines: it was formerly practiſed, at leaſt we may judge ſo by thoſe of circumvallation and countervallation. Moſt treatiſes of fortification prove this, and not only redouts, but ſtars, ſquares with half baſtions, and other conſiderable works.

The *Imperialiſts* ſeem yet to uſe them, for we found them in 1734 at the lines of *Etelingue*; as for us, we have abandoned them; the laſt time we uſed them was I believe at the lines of the *Loutre* in 1706, where we erected ſome redouts in the moſt expoſed places, and chiefly to defend the dams, and to place batteries in.

At the ſame time perhaps we abandoned the epaulments for the cavalry, whoſe uſe we ſhall treat of hereafter; it is not only neceſſary to know what is practiſed, but what ſhould be practiſed; that is, whether we have greater reaſon to ſuppreſs the one, or neglect the other; for it is ſometimes with theſe, as with faſhions, which many follow without reflec-

reflection, and some for fear of being thought singular.

M. Vauban, in his memoirs on the conduct of sieges, says, these works were no more constructed, because they were found dangerous; but the only reason he alledges in his *Treatise of the attack of places*, wrote many years after, is that of the brevity of sieges; thus he does not determine definitively, besides he only speaks of the circumvallation.

I shall not take upon me to decide this point; therefore what I shall say, must only be regarded as one single opinion, which I am obliged to venture by the nature of my subject.

XXXII. Fig. 1. There is no doubt, but this method, well managed, might be useful in many respects. These pieces elevated more than the rest, placed to advantage, by their protection and command of ground, might defend the adjacents parts; they are asylums at small distances, under whose fire the troops, drove back, or broke, may take breath and rally; it is also common in a brisk attack well supported, to be forced to abandon a battery, which when regained, and it is not without example, the enemy will have nailed up the cannon or have been very careless; by this we are less exposed to such inconveniencies.

According to the *Marquis Santa Cruz* (*a*) we gain another advantage. He would have us regard an intrenchment, as divided into four parts, and each part given to the com-

(*a*) On encampments, chap. 7. sect. 2.

mand

mand of a general, who ſhould march with his troops, to form in the place deſigned, if the enemy attacks on that ſide; and they cannot form with more order and tranquility than under one of theſe pieces.

Thus we have ſhewn their advantages; on the contrary, if the enemy once enter theſe works, the loſs of the lines is almoſt certain, by the difficulty of diſlodging them.

If this is the only inconvenience, as I believe it is; we may eaſily remedy it. Theſe works are of evident uſe, they muſt than be made; we have every thing to fear if the enemy once take them, they muſt then be conſtructed with ſo much care, as to hinder their acceſs, and not expoſe ourſelves to ſuch danger.

When I ſay they muſt be made, we muſt underſtand, that it is not in indiſtinctly on every occaſion, but only when we have time to put them into ſuch a ſtate, as not to be carried by aſſault, and principally in lines conſtructed at leiſure, and deſigned to laſt a long time.

All kinds of works are not proper in this caſe; we muſt above all avoid thoſe which batter any part of the intrenchment; for in an alarm in the night, and often in the day, the ſoldiers bordering the parapet, fire confuſedly on all ſides. The ſtar, a dangerous piece, if within reach of another, ought for example to be avoided. The chief care, in my

my opinion, is to perfect the works, and cover the ſpace between as much as poſſible.

Observations on the eighth Chapter.

The manner of conſtructing lines and retrenchments is here continued; but, as in the former chapter, thoſe made with redans, or with ſaliant and rentring angles, have been chiefly conſidered; here they are made with baſtions, as may be ſeen in plate 21. The firſt figure repreſents one conſtructed in the uſual manner; but as the ditch is but narrow, and its counterſcarp parallel to the parapet, a part near the ſhoulders of the baſtions cannot be ſeen from the oppoſite flanks; for which reaſon it ſhould be ſloped; and if a greater defence be deſired at the ſaliant angle, the ditch may be widened from thence towards the ſhoulder. But becauſe the conſtruction of baſtions requires too much time and labour, it is not always convenient, nor neceſſary, to make them all round; beſides, all parts are not alike expoſed, and therefore the weakeſt ought to be ſtrengthened by ſuch works, as to render their approaches as dangerous as that of the reſt. This was done at the ſiege of *Philipſbourg* in 1734, where the line of circumvallation was partly conſtructed with baſtions, and partly with redans: the part moſt expoſed had beſides a horn-work added before the curtain; and others had double ditches, with

with pits full of ſtakes between them; laſtly, the part near the woods was ſtrengthened with felling of trees.

As the ſituation of no camp whatſoever is on all ſides the ſame, but has either a river, moraſs, or a riſing ground before it; it is the engineer's duty to make uſe of all the advantages which nature affords, and to ſupply its defects with ſuch works as are moſt convenient for the purpoſe.

The author obſerves, that as the ſtrait curtains have no other defence than directly before them, and the greater defence of the front is directed towards the part leaſt liable to be attacked, he gives an example in the ſecond figure, with broken curtains; as hereby a ſecond flank is added to the defence of the baſtions, and the fire is in effect more ſpread and better divided. It may however be obſerved, that when ravelins are placed before the curtains, this ſecond defence becomes in my opinion uſeleſs, and in that caſe I prefer the ſtrait curtain before the broken one.

The author ſtarts an objection againſt lines with baſtions, in my opinion more curious than uſeful, ſo far as relates to the real defence: but as all faults, tho' only in appearance, ſhould be examined, to prevent the reader from falling into miſtakes, we ſhall endeavour to remove all ſuſpicions which the author here inſinuates. He ſays, when an enemy has once got poſſeſſion of the baſtion,

and is not ſtrong enough to advance farther, it will be attended with greater difficulty to drive him out again than out of a redan: this he endeavours to prove by the two firſt figures in plate 22; where he obſerves, that a greater number of troops may be placed before the redan, in proportion to the enemy it can contain than before the baſtion, but the author forgot that the baſtions are well defended by a grazing fire, and that ſingle redans have no defence at all; beſides, as the baſtions are more ſpacious, there is more room for placing troops in them to defend the enemy's approach, and conſequently the attac of a baſtion is infinitely more dangerous than that of a redan. But let us even ſuppoſe, that the enemy has got poſſeſſion of the one or the other, will there not be a ſufficient number of men to drive them out again? thay cannot be ſuccoured in the baſtion without ſuffering a furious diſcharge of artillery and ſmall arms from the oppoſite flanks; unleſs the defenders give all over for loſt, and run away, they will have it always in their power to drive them out of the baſtion, and that with more ſlaughter than out of the redan.

The ſecond figure plate 22, repreſents an intrenchment, intended to have been made cloſe to a river; and as it was to be executed directly, time would not permit to make it of any other figure than a right line; but detached baſtions and lunettes were to be

added

added afterwards, ſuch as are marked here, whereby the author imagined it would have a good defence; becauſe, if the enemy ſhould get poſſeſſion of any of theſe detached works, he would be ſtopped by the wet ditch, and ſoon be drove out again by the gauling fire from the oppoſite part of the line. But as the faces of the detached baſtions are not defended from any other part, this conſtruction is defective on that account; whereas, if the outworks were conſtructed in ſuch a manner as to defend each other, they would then be able to make all the defence that could be expected. How it is that the author did not perceive this defect, which is ſo contrary to his eſtabliſhed principles, is impoſſible to know; unleſs age and infirmity had deprived him of his former ſagacity, which is not unlikely, ſince he died ſoon after this work was publiſhed.

When the approach of an enemy is ſo ſudden, as to leave no time for quite finiſhing the retrenchment, detached baſtions and lunettes ſhould be made at proper diſtances, ſo as to flank each other, and the curtains muſt be ſupplied by fellings of trees, if they are at hand, or by all kind of wheel-carriages, or elſe by ſtakes, timber, &c. and if there is any time afterwards, the curtains may then be made. But if a general is willing to run the riſk of a battle, artillery and muſketry muſt be placed in theſe detached works, and the intervals left open for him to march out

in order of battle when he thinks proper: if the enemy is resolved to push thro' these openings, the fire from the artillery and small arms, coming out of these works, may perhaps make him repent of his rash attempt, or at least disorder him in such a manner, that if the troops march in good order against him, it will be no difficult matter to defeat him.

The first figure in plate 23, represents an example of this kind, with this difference only, that the advanced works do not flank each other but very imperfectly, which is so much the more surprizing, as the author insists so much upon it, in most of the former parts of this work: whether he imagines these flat bastions to be more commodious, or that the enemy will rather chuse to pass between than attac them, I do not know; but in my opinion he will not pass by them, before he has destroyed their faces, and has taken them, which he may easily do since there is nothing that can prevent him, if he has artillery, and without which no army now marches; on the contrary, it is what the success of all actions chiefly depends upon.

The second fig. plate 23, represents another kind of detached works, which requires more labour and more time then the former: it is true, the parts defend each other much better; but I think the end of the one does not so well defend the end of the other, than

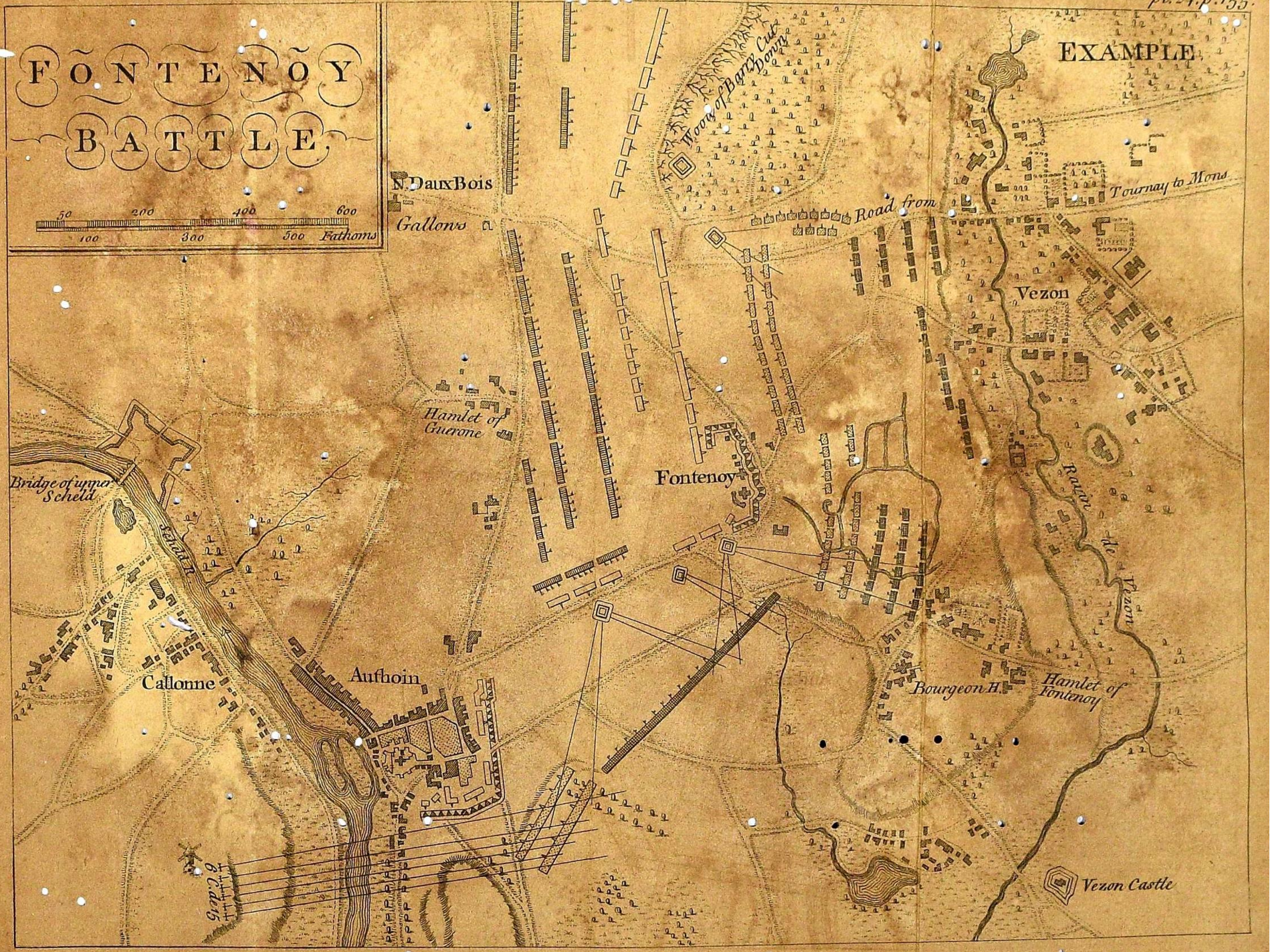
if

if their defence was juſt to graze the oppoſite angle: be this as it will, ſuch examples as theſe are always uſeful, as they inlarge the number of different manners. in which lines may be made, and ſometimes one form, at others another, may be uſed, according as the nature of the ground will permit, and all of them may be uſeful in different occaſions and circumſtances.

After all the different conſtructions of lines that the author could think of, he ſays, it has been a queſtion for ſome time, whether it was proper or not to join works incloſed on every ſide, to lines or retrenchments; that is, redouts or forts. Some authors are of opinion, by placing them at proper diſtances, that when an enemy has entered the lines in ſome parts, the troops in the adjoining parts of the line may rally and form themſelves under the protection of their fire; and that they ſerve as ſo many points fixed, where the troops are to join, in caſe the enemy ſhould penetrate the line in any place. On the contrary others maintain, that ſuch works are dangerous, in regard, that if the enemy ſhould get poſſeſſion of any, it would be very difficult or almoſt impoſſible to drive him out again. In all queſtions of this kind, the general manner in which they are propoſed renders them ſeemingly more difficult to ſolve, than they otherwiſe ſhould be; for if a particular work is not proper upon one occaſion, is there any reaſon for its not being

ſo in any other? It would be much more to the advantage of the reader, to find out where and when a work of a particular kind may be uſeful: for there is none but may be good on ſome particular occaſions. Thus when an advanced fort can be turned, or one near the ſea or a river can be attacked in the rear, it is evident that it ſhould be fortified all round; how many batteries have been taken, as well as forts, for want of this precaution. As to forts in or without lines, if it is difficult to drive an enemy out of them, it muſt likewiſe be as difficult for an enemy to get poſſeſſion of them. The query lies then, whether ſuch a work may not be made ſo ſtrong, as that the taking of it would coſt a greater loſs of men, than the poſſeſſion is worth; that this can be done there is no doubt of; and therefore when a general judges ſuch works neceſſary, he ought to ſee it made, ſo as to anſwer his deſign; but if time or circumſtances will not allow it, he would be to blame to expoſe his troops in a uſeleſs manner. It is upon ſuch occaſions, that the judgment of a general, and the ſkill of an engineer, muſt decide what is to be done, in order to ſecure his army from the danger of being defeated.

CHAP.


FONTENOY
BATTLE
50 200 400 600
100 300 500 Fathoms
N. Daux Bois
Gallows
Wood of Barry Cut Down
Road from
Tournay to Mons
EXAMPLE
Vezon
Hamlet of Guerone
Fontenoy
Bridge of upper Scheld
Callonne
Authoin
Bourgeon H.
Hamlet of Fontenoy
Rau de Vezon
Vezon Castle

CHAPTER THE NINTH.

I. *Advantages to be drawn from a river, to cover lines.* II. *What is to be done in flat ground, when under the fire of the intrenchment.* III. *When it is at a distance from the whole, or any one part.* IV. *Of inundations; case where they may be made by single dams.* V. *Those made with sluices; their inconveniencies.* VI. *A more perfect scheme.* VII. *Scheme of an inundation for lines that are to stand a long time.* VIII. *Multiplicity of dams; means of correcting them.* IX. *Dams too long: means of defending them.* X. *Recapitulation of all these defects.* XI. *A new method of forming inundations in flat ground, in any place.*

I. OF all the assistance that can be expected from the natural situation of the ground for the defence of intrenchments of great extent, such as lines, there is not any more advantageous than a body of water, which is, or can be made, so deep as not to be forded.

This assistance, so desirable, would naturally present itself, without any necessity of improving it, whenever there is a large river in front, was it not for one circumstance, always to be joined to it, namely, that it might not be turned by the enemy.

It is very rare to find theſe advantages united: the courſe of a river, ſuch as we here ſuppoſe, is always of ſo great extent, that it is impoſſible to line one of its ſides entirely; and whatever may be the ſituation, or extent, the intrenchment will not hinder an enemy from paſſing above, or below it.

Theſe rivers therefore, ſpeaking in general, cannot ſerve for this uſe, but may become themſelves almoſt an impenetrable barrier, by the help of much leſs, and quite different works, which we ſhall treat of in chap. 10.

Moſt ſmall rivers are preferable in this caſe to large ones, for they commonly riſe in the mountains, and running through a flat ground for ſome leagues, empty themſelves into others much more conſiderable.

The great river and the mountain, in this caſe, ſerve to cloſe and ſupport the extremities of the line, and there is no more to do, than to render the front difficult of acceſs, by the aſſiſtance of the ſmall one; which is executed after different manners, according to time, places and other circumſtances.

II. We have before obſerved, that when a riſing ground or eminence runs parallel to the river, the line muſt be traced on it, as well to have a command, as that the camp may be more dry and wholeſome, and the communications be on firmer ground, the better for carriages.

When the line thus traced is every where at a proper diſtance from the river, that is from 80 to 100 fathoms, it is a great advantage, becauſe the paſſage is defended by ſmall arms, without much labour and trouble.

If the meadows between are level and of a great breadth, ſo that they cannot retain the waters, or if time or means is wanted to undertake a greater work, it will be ſufficient to raiſe them within their own banks, and keep up the water at certain ſpaces that it may not be forded: there are few that have not banks 5 or 6 feet deep, and that is ſufficient; if they are ſteep, they are a greater obſtacle to the enemy.

Theſe waters are commonly ſupported by dams of earth, which being raiſed above the banks, force the water over the meadows; theſe works, the only ones I have ſeen, have a great inconvenience, as they ſerve for bridges to the enemy. Thoſe I invented at *Deckendorf*, and uſed in 1743 at the camp of *Queich*, are exempt from this defect.

Their number depends on the greater or leſs fall of the river, and the height of its banks from the water; for example:

If this fall be two feet in 100 fathoms, and the depth of the bank only five feet; the dams muſt of courſe be repeated at every 25 fathoms, in order to make the water riſe four feet and a half, which is the proper height to prevent its being forded.

But

But if this fall be only ſix inches, and the banks 7 feet, a dam at 500 fathoms diſtance will produce the ſame effect.

III. In the preceding article, I have ſuppoſed the whole courſe of the river under the fire of the line; a very advantageous circumſtance, becauſe the enemy may be prevented from throwing bridges over it, or cutting the dams; yet when the river runs above 100 fathoms from it, which I reckon a very proper diſtance for ſmall arms; by additional works, as much or more aſſiſtance may be drawn from it.

Pl. XXV. Fig. 1. If it runs off in elbows, which are neither too open, nor too much ſunk, ſome advanced works, joined to the intrenchment by good communications, will be ſufficient to protect them.

Pl. XXV. Fig. 2. If the depth or breadth of theſe curves render that expedient ſubject to difficulties, a canal muſt be cut from one extremity of the curve to the other, in a ſtrait line, obſerving to dam the old bed, as will be ſhewn hereafter, leſt the enemy ſhould turn off the water.

When the river is every where at too great a diſtance, a new bed muſt be dug for it, in order to draw other advantages beſides thoſe which the nature of the ſituation affords.

The direction of this new bed requires ſome eſſential obſervations: if the eminence, on which the intrenchment is ſuppoſed to be, is too high to carry the water up, or the ſide next

next the meadow very ſteep, the canal may be cut from 15 to 20 fathoms diſtant, or more, if that is not ſufficient to command it throughout, throwing the earth on both ſides, in form of a glacis, which increaſes the depth. I ſay from 15 to 20 fathoms, becauſe that diſtance does not diminiſh the effect of ſmall arms, and a ſoldier, eſpecially if he is not well diſciplined, will be leſs confuſed, and fire more exact, than if the enemy was nearer,

Where the hill is ſteep, the line ſhould lie as cloſe to the edge as poſſible, and the ſide ſcarped, to render it difficult to mount the intrenchment; and where it is neceſſary to run off from the ſide, it muſt be made in form of a glacis, ſo as to leave no cover before it, which alſo furniſhes earth for its conſtruction; at leaſt in the firſt caſe, without being under a neceſſity of digging a ditch, which being very low in regard to the ſummit of the parapet, will be badly defended.

In the other caſe, that is, if the intrenchment ſlopes gently down to the meadows, and the river can be brought there, nothing better can be done than to turn it into the ditch; which is then indiſpenſable, as well to defend the acceſs to the parapet, as to get the earth of which it muſt be made.

The river, which muſt be dam'd at the place it quits, and where it falls again into its old courſe, being at leaſt ſufficient for a reſervoir to ſupply theſe two different canals with

with water, will alſo ſerve as a double barrier to the intrenchment.

IV. When the river flows without much rapidity, in a valley, border'd by riſings, or when the ground riſes gradually to the right and left of the river, all before it may be laid under water.

Theſe inundations are made by dams of earth, which barring the river and the loweſt part of the ground, retain and elevate the water; but as the water may carry away the dam if it ſhou'd overflow, care muſt be taken to make proper voiders.

Experience ſhews, that ſhallow water flowing on natural ground, does not hollow it, when it can extend itſelf. In conſequence of this obſervation, whenever the valley ſlopes towards the river, there is no occaſion for any other diſcharger than the ground itſelf beyond the dam; but for greater ſecurity the ends muſt be hurdled and gazon'd.

Another material advantage reſults from this work: for, whether the enemy cut the dam, or turns off the water by a canal, they can only drain one part of it; becauſe to drain it entirely, they muſt dig and advance, as it runs off to the very loweſt part; which as not to be done in one night, affords time to diſcover and oppoſe them; beſides, they cannot do it without being greatly expos'd to the fire of the intrenchment.

V. Theſe natural dischargers ſave much work,

work, and do not require great care in uſing them; but they are only to be us'd in ſuch places as I have mention'd. But where the valley is level, or ſo narrow that the ends of the dams muſt be carried to the riſing grounds, or even from one hill to another, it is evident, recourſe muſt be had to other means. In that caſe ſluices of wood are conſtructed, and placed according to the uſe they are deſign'd for.

When they ſerve as diſchargers only, they are erected on the meadow, and the flooring fix'd on the level of the ground. The advantage reſulting from this, is that there is no excavation requir'd but for the foundation, and theſe ſluices being leſs high by the depth of the river, require leſs time and wood for their conſtruction; they are alſo eaſier manag'd. Theſe advantages are counter-balanced by different inconveniences; the river not being able to paſs over the flooring, cannot have its natural courſe, without cutting the dams that ſtops it; which is neceſſary to be done, when the enemy is at a diſtance, or when at the end of the war, in order to drain the inundation.

Theſe diſchargers require beſides a continual attention; for the baſons once full, the vanns muſt be rais'd to a certain height to let a quantity of water paſs, exactly equal to what enters; I ſay exactly equal, for if they are rais'd too high, the inundation falls, and

if

if the oppoſite extreme, it may prehaps blow the ſluice and carry off the dam.

A few hours rain, or a ſudden thaw of ſnow, conſiderably ſwells theſe mountain rivers; they muſt therefore be watch'd night and day. In ſhort, a cannon ſhot, or ſome defect in the wood, or their conſtruction, may diſorder the whole in a moment.

VI. The count *d'Aumale* having order'd me during the campaign in 1743, to put the lines of the *Loutre* in condition; theſe conſiderations oblig'd me to ſeek ſome method more ſimple, more ſure, and leſs fatiguing to diſengage from the ſuperfluous water ſome new dams I wanted to raiſe, and repair alſo moſt part of the old ones; for my deſign was to dam thoſe ſluices moſt expos'd to cannon; and thoſe that are made as low as the bottom of the river, ſupport a great height of water; which renders them leſs ſecure and more difficult to manage.

I was reſolv'd therefore to uſe reſervoirs of wood, the flooring laid on the interior ſide, three or four feet lower than the ſummit of the dam, had according to this ſcheme a convenient ſlope. Five poſts with grooves divided the entrance into four equal parts or paſſages, making together 24 feet opening, which is double the common breadth of theſe ſluices, and may perhaps appear exceſſive, if I did not give my reaſons for ſo doing.

Water

Water paſſing thro' a ſpace double in breath to another, runs about half as high, which renders the inequality of the body leſs ſenſible; it is therefore much eaſier to keep the inundation at a certain height by means of theſe ſhutters.

Beſides, if one of the upper ſluices is carried off, or one of the dams ſhou'd burſt, all is in danger, if the diſchargers are not large enough to give ſufficient room for this additional water to ruſh out. It is for that reaſon I make the floors of the reſervoirs ſo low; for in ſuch an emergency all the ſhutters muſt be rais'd, tho' it does not appear neceſſary; for the upper waters continually encreaſing the breach they have made, come down ſuddenly in greater abundance.

Theſe reſervoirs ſhould be made at a little diſtance from the line on the meadow, and not in the river, becauſe the depth would render them leſs ſolid. As they have leſs wood work uncovered, and as the ſhutters ſupply the place of vanns, they are more ſecure from cannon than ſluices, to which I think them preferable, as well for the above reaſon, as being of a much lighter and ſimpler conſtruction, there is no more Time required for them, than what the ſoldiers, or pioneers employ to raiſe the dam, ſo that all is finiſhed at once.

VII. When theſe lines are made to ſubſiſt all the war, or even in peace, one would chuſe that theſe inundations may be made

and filled on the first order, that is to say, in the short time necessary for filling or emptying their basons, some little additional work must be done.

Each dam must in this case have a sluice, the cill of which must be as low as the bottom of the river, and the floor large enough to let the water pass at all times, the course of the water not being constrained, the dams need never be cut to let out the water on any emergency, when they are settled and well sodded; such in short as we need not fear. This is the only use I think we should make of these sluices, as well for the reasons already given, as the following.

First, Their height being equal to the depth of the river, it is often very difficult, and sometimes impossible to raise or lower the vanns, in a great depth of water; for these vanns being very high, are greatly pressed against their grooves, tho' supported by the lower inundation. I here suppose the common vanns, because they are subject to less inconvenience, than those of a more complicated construction.

Secondly, The superficies of the inundation must be regulated by the shutters, and the river must fall entirely in a cascade. It is easily conceived what the floor must suffer, by the continual pressure of such a body of water, as well by its weight, as its whirling, and the mud which will be gathered there.

Thirdly,

Thirdly, Finally these sluices are commonly founded in clay; but as liquids press in proportion to their depth, the least filtration between the earth and floor, increasing every moment, may blow it up. The cill indeed is more secure, because of the dovetail'd piles, which should be drove before and behind it.

These sluices serving only to retain and drain off the water, and not to keep it at a determin'd height, have no occasion for vanns. Two rows of piles, distanced from each other in proportion to their height, serve for, and form with the checks, a coffer, which is fill'd with earth well ramm'd, or with clay. This batardeau secures the front piles, which it supports, and the floor which it bears on; we have thus nothing to fear from cannon. As to the superfluous water, it is discharg'd by such a reservoir as I have mentioned.

I shall say nothing here of the different ways, which according to time and means, we may turn the old sluices of this kind, into reservoirs and dischargers; because I reserve that detail, and the different works which I here only hint at, for a particular treatise on their construction.

VIII. Having thus shewn my opinion on the different methods of covering lines by inundations, I will here remark the principal difficulties attending, and the means I would recommend to surmount or avoid them. The construction of dams is subject to two inconveniencies; their multiplicity caus'd by the

the great fall of the ground, ſhall be the ſubject of this article.

Theſe dams made of earth (for thoſe I promiſed the conſtruction of, will be of no uſe here) are, as I have already remark'd, as many bridges for an enemy, and conſequently an annoyance and fatigue to an army to guard them. The only remedy I know of for ſo eſſential a defect, is to make them only at all thoſe places, which are deſigned for poſts; becauſe this decreaſes their number, and to make them as high as poſſible with prudence. If there are ſluices in the river, there will be found an advantage, which perhaps does not preſent itſelf at firſt view.

Suppoſe the river five feet deep; if the cheeks of the ſluice are only rais'd 9 feet, it is evident they will throw but 4 feet water on the meadow. If there are four ſluices following each other, and diſtanced ſo that each ſupports theſe 4 feet of water, there remains two below the foremoſt dam, which is the leaſt that can be to hide the bottom of the river and prevent its being fill'd up; I ſay that one ſluice only of 15 feet high, will be of more effect than thoſe 4 of 9 feet each, and which taken together are conſequently higher by 21 feet.

This difference happens from the great ſluice being only once hid 5 feet in the river, and throws alone 10 feet water over the meadow.

The

The little ones on the contrary being repeated four times, loſe 20 feet, which gives 15 feet difference. The 6 feet remaining proceeds from this, that except the laſt, each of theſe ſluices only ſupporting 2 feet more of water, than that follwing it, there are three which loſe 2 feet each. Another advantage of the great ſluice is, that it throws 2 feet more water between the firſt and ſecond ſmall ones, 4 feet more between the ſecond and third, and 6 feet more between the third and laſt.

Dams, ſluices, or reſervoirs raiſed on the meadow have entirely this laſt advantage; but it is not near the ſame with reſpect to their difference in height, becauſe of the 5 feet the depth of the river, which is only once reckon'd; ſo that by the ſame ſuppoſition, 10 feet will produce the ſame effect as 16. The profil will explain what may appear obſcure in this article. The thickneſs of theſe dams, increaſing in proportion to their height, certainly require a greater quantity of earth; but they diminiſh the number of ſluices and reſervoirs, and, what is more eſſential, there are fewer bridges to guard.

If I ſuppoſe theſe retainers of this height, it is only to make this propoſition more intelligible; for being only neceſſary to have them of timber and clay, and not of maſonry, which is too ſolid for field work, I would not have them exceed 12 feet: this will even be too much for ſluices with vanns; but to

prove that thoſe I propoſe are capable of that reſiſtance, it is ſufficient to recollect that their coffers make them real dams, and tho' they are 12 feet high from the floor, they have not 12 feet of water to ſupport, there being but 5 feet difference between the upper and lower inundations.

When the valley is to be overflown, the lower ſluice is ſhut firſt; and when the water is riſen to a proper height the next is ſhut, and ſo on; otherwiſe the water wou'd not be of the ſame height in all places.

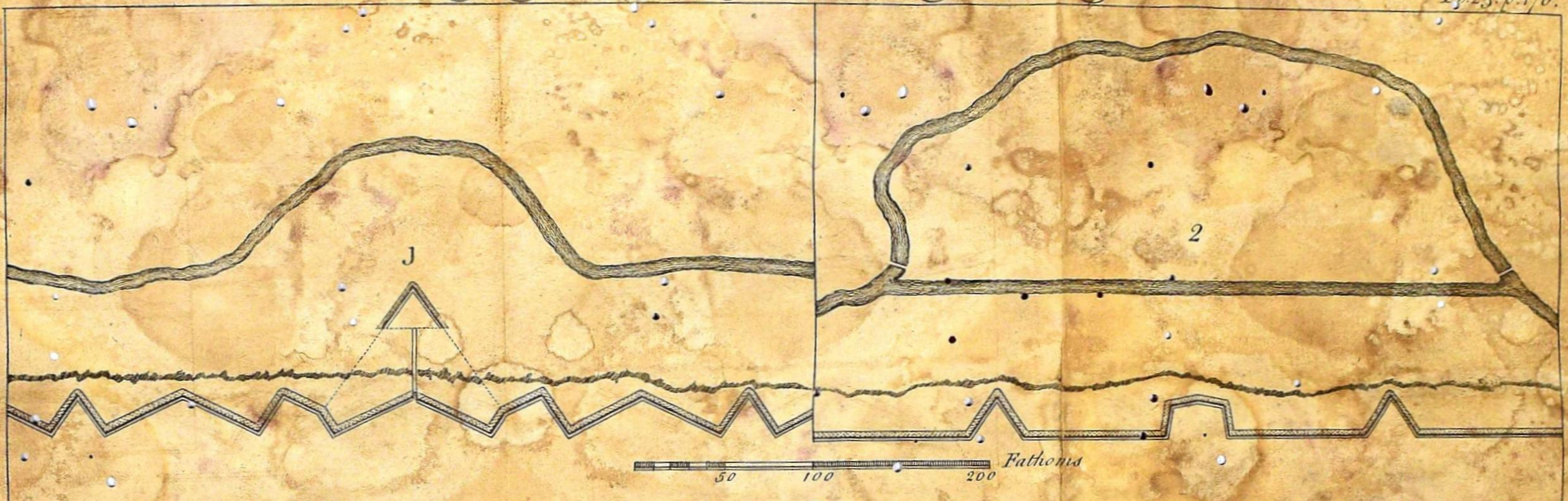
IX. The exceſſive lengths of the dams, cauſed by the diſtance of the places proper to ſupport their extremities, form the ſecond inconvenience.

Pl. XXVI. Fig. 1. As the protection of theſe works is a very material point, they muſt be rais'd in the narroweſt part of the valley, that their heads may be defended by the line, as much as poſſible. As this advantage cannot always be obtained, if it be 60 or 80 fathoms diſtant, a lunette muſt be conſtructed to hold at leaſt a hundred men, and turned ſo as to be flanked by the retrenchment.

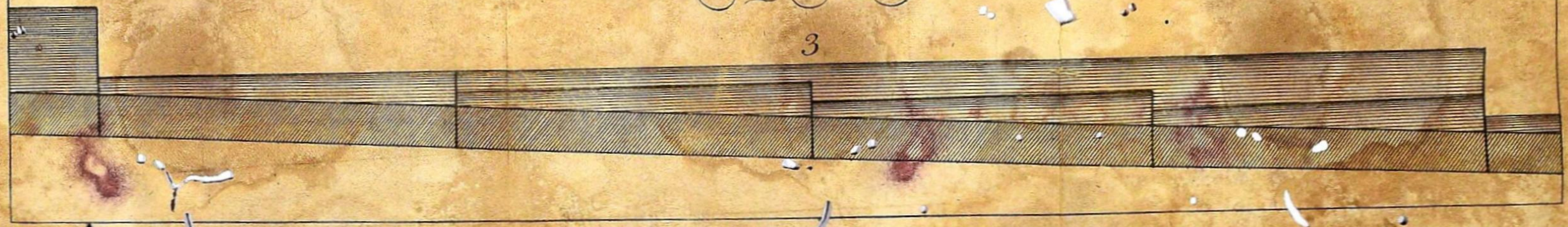
Pl. XXVI. Fig. 2, 3, 4. But when this diſtance exceeds 80 fathoms, the ſureſt way, I think, is to raiſe a redout on the inundation itſelf, or breaſt works, 30 or 40 fathoms from the oppoſite ſide, which may croſs the dam: the opening next the enemy muſt be covered by a turning traverſe. This muſt alſo have a lunette, which only

ſerving

LINES COVER'D by RIVERS



SLUICES



ſerving as an advanced work, or rather a look-out, may be much ſmaller than the others.

A double parapet raiſed on the dam will ſecure the communications of theſe different works, at leaſt from one piece to another, if the quantity of earth required ſhould be too great. The author's meaning muſt be, that a ſingle parapet is to be made only, in caſe the weight of the great quantity of earth is too much, and not as it is expreſſed above.

This calls to my mind, the method taken to conſtruct one of the dams of the *Loutre*: It is an intrenchment covered only on one ſide, which by its ſeveral turns is ſecured from enfilade, and yet oppoſes a croſs fire, ſuperior to that from a point of land, ſtretching out from a hill. This work, which does honour to the engineer who directed it, ſhews what may be done on like occaſions.

X. The difficulties found in covering lines by inundations, I think may be reduced to the three following caſes.

Firſt, When the ground, thro' which the river runs, is on a level for too great an extent; how can water be raiſed on a flat ſurface, without means of confining it? Yet this is not impoſſible; but I don't know that it was ever attempted.

Secondly, When for the ſame reaſon, the dams are obliged to be made exceſſive long, for want of nearer ground to ſupport their heads, they require much work, and poſts in front; which being liable to be attacked at

at a time when darkneſs renders the defence drawn from thoſe in the rear weak and uncertain, give poor encouragement to officers charged with ſuch poſts.

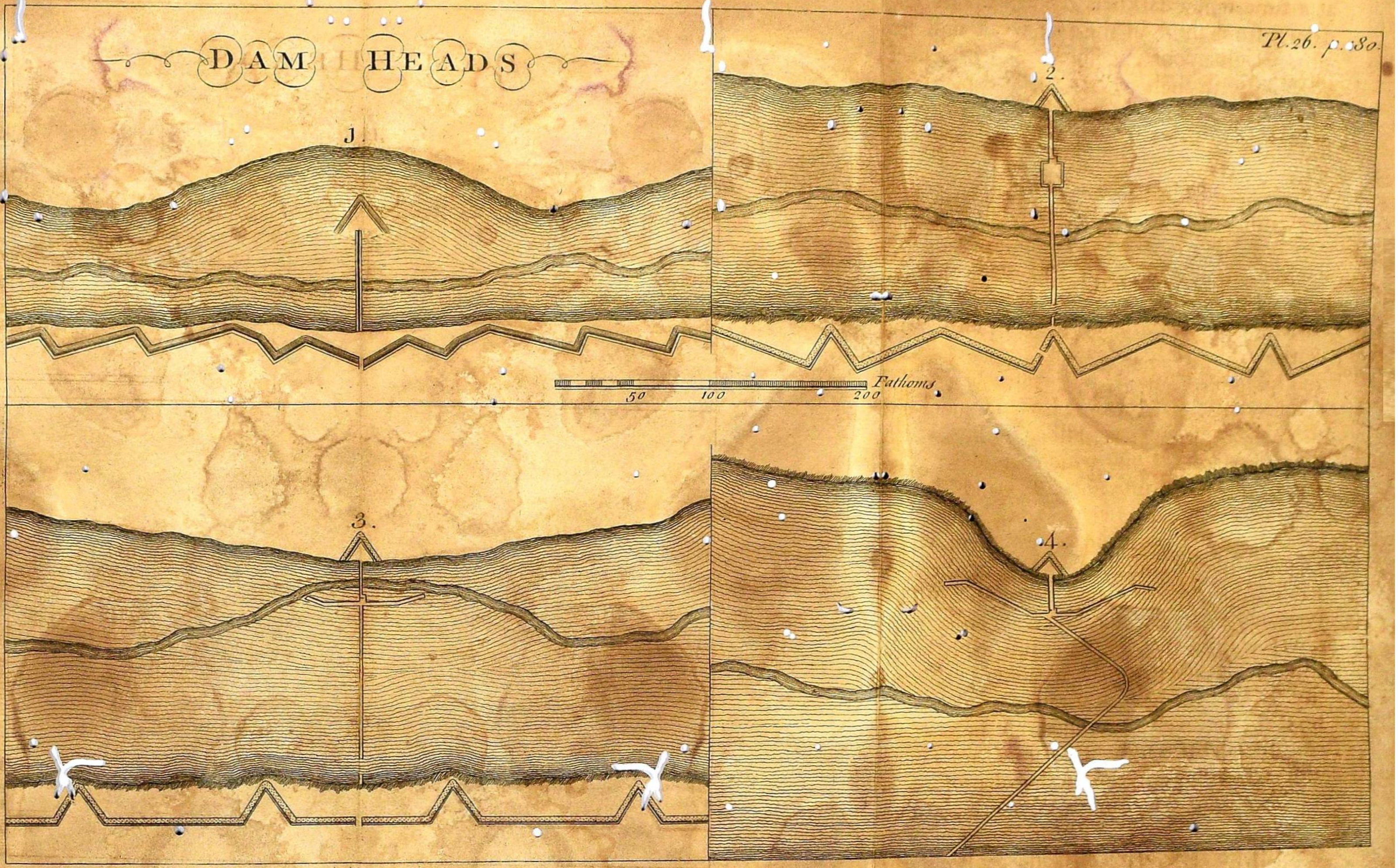
Laſtly, when the great fall of the river renders it neceſſary to multiply the dams, which (without reckoning the increaſe of workmanſhip) are ſo many bridges to guard, they muſt of courſe be carefully watched.

I have ſhewn what is commonly done in each of theſe caſes, but if I was charged with ſuch an undertaking, I would avoid theſe obſtacles, and go quite another way to work.

This expedient I think preferable to the common method, for by it I would undertake to render the line inacceſſible without theſe ſluices, or long dams, which are ſo troubleſome, or thoſe poſts, advanced and dangerous, and with a quarter of the expence.

This ſcheme, as plain as new, I contrived, by order of the court, in 1735, for the lines of the *Spirbach*. This river we have ſhewn runs almoſt every where at a conſiderable diſtance from the hill, flows full to its banks thro' flat and very broad meadows. Neceſſity obliged me to ſeek a remedy for all; in fine, I poſitively promiſed an inundation, commanded throughout by ſmall arms; but without explaining the method I propos'd to follow: this was perhaps eſteemed a chimera; be that as it will, I heard no more of it, and a little after, two brigades of engineers

were


DAM HEADS
1.
2.
3.
4.
50
100
200
Fathoms

were detached from the army, and charged with theſe lines. I could not with decency propoſe my ſcheme, as they did not demand it of me, ſo that the opportunities of executing it at the camps of the *Loutre*, and of the *Queich* in 1743, not taking place, I never produced it, nor even committed it to writing; however, the publick may judge by the following, if it has any other merit than its novelty.

XI. I ſuppoſe all the above difficulties united, that is to ſay, the valley quite level and of a great breadth, which, according to the common method, renders all ſchemes impracticable, and the river flowing full to its banks, has only 4 feet depth and 2 feet fall in 100 fathoms,

My method leaving me at liberty to preſcribe what breadth I pleaſe to the inundation, I will examine what is the moſt advantageous; if it is too narrow, it is not a ſufficient obſtacle to an enemy; if too wide, it is badly defended, and the dams extending in proportion require more work. Theſe things conſidered, I determined its breadth between 40 and 60 fathoms. XXVII.

I trace the ſide 60 fathoms from the curtains and other principal lines of the intrenchment, obſerving in thoſe places where the riſing, and conſequently the fortification winds, to follow thoſe only of a great extent, and to contract the breadth before the others, that is to ſay, to run out from 40 to 60 fa-

thoms, according to the greater or leſs projections of theſe parts; becauſe the more it approaches to a right line the leſs extent it will have.

Six feet within, trace a parallel ditch from 15 to 20 feet broad above, and from 4 and a half to 6 feet deep, according as the water will permit: the earth dug up will form the dam made lengthways to ſupport the inundation, preſerving 6 feet for a berm, and this dam is ſtopped ſo as to leave no cover for the enemy.

If I have no wheelbarrows, I make another ditch parallel to this at the foot of the intrenchment, which in this caſe follows its windings; if not, it muſt be contrived that the ſcarp may be ſeen throughout from the parapet.

The breadth being thus determined, I trace the retainers at every two feet deſcent, that is, according to the ſuppoſition, one at every 100 fathoms. Theſe retainers are formed over the whole breadth of the meadow by dams of earth, and over the ditches by batardaux's of wood; the reaſon of this difference will preſently be ſeen.

The dam on the ſide begins at 3 feet height, and ends at 5; that which croſſes the meadow, ſuppoſing the baſon level, is raiſed very where to 5 feet, tho' it ſuſtains but 4 feet water in the deepeſt place, which is ſufficient to leave 2 feet at the foot of the upper retainer;

tainer; but this foot is alſo neceſſary to prevent the water from overflowing.

The earth for the dams of the retainers is taken from a ditch dug above, and as deep as thoſe to which it communicates at the extremities; leaving 6 feet berm at leaſt between the foot of the dam and the ſcarp of the ditch, whoſe ſlope muſt be equal to its height at leaſt.

The dam batardeau adjacent to the ſide of the inundation muſt be made ſo that it cannot be walked over; and as it cannot be waſted by the water, it may be level with the ſurface; it will likewiſe ſerve as a reſervoir in caſe of need. How a batardeau can ſerve as a reſervoir is not poſſible to be underſtood; excepting the author means, it ſerves to make a reſervoir in caſe of need.

The other is of a different conſtruction; a ſingle vann in the middle, without any more expence, will have the ſame effect as a ſluice, which coſts much more; this vann being raiſed, will fill the ditches, which communicate with each other, in a little time, by cloſing the vann, and throwing the river into its old courſe, it will ſerve as a reſervoir; in ſhort, when an inundation is to be made, ſome planks, ſlipped into the grooves, will ſupport it to a determined height.

The only objection I know, that may be made to this method, is the loſs of water cauſed by filtration thro' the lateral dams. This does not appear probable to me, as they are

are very low and thick; but ſuppoſing this filtration, it can be no inconvenience, as we need never want a ſupply of water from the river. If it is feared that the vanns are not ſufficient, the ports of the dam, which form the reſervoir, muſt be lowered by ſome inches, however, ſo as that they are higher as they deſcend with the ſtream; the conſequence of ſecuring the entrance of the water is manifeſt, ſince it is upon this the whole depends.

This method is equally good to cover lines entirely by inundations, and to correct the defects of thoſe already conſtructed after the common method.

Observations on the ninth chapter.

As there are few countries without rivers or brooks, the manner of taking advantage of their courſes, in retrenching camps, is here particularly conſidered; and as the author ſeems to be ſomewhat obſcure, ſo as not to be eaſily underſtood, by readers who are unacquainted with theſe works, a more particular explanation of ſo uſeful a ſubject will, I hope, not be deemed uſeleſs.

He ſays, that when a large river runs in the front, it forms almoſt an inpenetrable barrier, by the aſſiſtance of very few works; but as its great length cannot every where be ſufficiently guarded, the enemy may paſs it either above or below, and attack the camp

in

in the rear or in flank, as he finds it moſt convenient. But ſince the river is a ſufficient defence in the front, the attention of a general ought to be confined to the ſecuring his flanks and rear, either by works in thoſe places, which are moſt eaſy of acceſs, or by moraſſes, if there be any at hand, or in general by all poſſible means, that nature and art can afford: but if the enemy croſſes the river with an intention to hem him in on all ſides, the general muſt know whether his camp can be forced or not; if not, whether he has means to ſubſiſt his army till the enemy is obliged to retire.

If a river is not very large, and its courſe may be carried round the greateſt part of the camp, or has a conſiderable bent, ſuch a ſituation is certainly very favourable, provided the ground on the oppoſite ſide does not command the works of the camp; it is likewiſe very advantagious to have a ſufficient quantity of ſweet water ſo near the camp, that the enemy can by no means cut it off, for the uſe of both men and cattle; for all other neceſſaries but that may be tranſported from other places.

If a river is ſo ſmall as to be eaſily paſſed, dams may be made at proper diſtances, ſo as to raiſe it higher; or if the ſituation is favourable, an inundation may be formed, of ſuch an extent, as not to be croſſed without the utmoſt difficulties. But in both caſes, great care muſt be taken to prevent the

enemy

enemy from cutting theſe dams, and to let out the water; for which reaſon ſtrong guards muſt be placed near them, and ſecured either by a good redout, or any other ſuch work, as the nature of the ſituation will admit.

If there is a riſing ground within 60, 80 or 100 fathoms of the river, the camp muſt be placed upon it, and an inundation formed, if it can be done between the river and camp: but when that diſtance is too great for ſuch a work, two ditches may then be made nearly parallel to the riſing ground, and within 40 or 60 fathoms from each other; theſe ditches muſt be croſſed by two others, ſo as to bring the water from the river into the former; or if the ground between is low, to form an inundation. The reader muſt be ſenſible, that the whole ſecurity of ſuch a work depends intirely on the well guarding the dams which keep up the water; for if they are not, the enemy may paſs them, being ſo many bridges ready made, or demoliſh them, juſt as he finds it moſt convenient.

When the water of a river is to be raiſed to any moderate height, the author prefers a ſingle dam of a ſufficient height to three or four ſmall ones: thus if the water requires to be raiſed 10 feet at the lower end, and the banks are 5 feet, he prefers one dam of 15 feet high to four of 9 feet, placed ſo as to raiſe the water to the ſame height above. His reaſons are, that the height of the four dams amounts

amounts to 36 feet, and therefore the difference between this and 15, the height of the one, is 21 feet, and the four require four guards instead of one, which fatigues the army. How it happens that the four raise the water no higher than the one, is thus made out; the first or lowermost will raise the water four feet above the bank; and as two feet of water above the bank is reckoned the least that can be allowed to hide the bank; the second is placed where the height of the water is two feet above the bank, and therefore can raise the water but two feet higher; and the third and fourth will raise the water no higher for the same reason; so that the lowest raises the water four feet, and the three others together 6, which makes 10 feet in all; and is the same as one of 15 feet sunk 5 into the river.

To shew how much the work of the four at 9 feet high exceeds the one at 15, it must be observed, that the pressure of water against a perpendicular surface is equal to the weight of a triangular prism, whose height is equal to the breadth of the river, and the base and posales right angle triangle, two sides of which are equal each to the height of water. Now since the height of these prisms are the same, viz. the breadth of the river, and their bases similar triangles, and these similar triangles are as the squares of one of their sides, the total pressures are to one another as the squares of the heights of the water:

water: and as the ſolid content of theſe dams muſt be proportional to the weights they ſupport, the quantity of the work in a dam of 15 feet high is to that of one of 9 feet high, as the ſquare 225 of 15 is to the ſquare 81 of 9: and as there are four of 9 feet high, and 4 times 81 makes 324, the quantity of work in the one is to that in the four, as 225 is to 324, or as 75 to 108; which is not ſo great a difference as might have been expected. This is upon the ſuppoſition, that all the dams ſupport a quantity of water proportional to their height, which is not here the caſe; whereas it ſhould only be the difference between the height above and below each dam; and as this difference is only two feet in the three upper dams by ſuppoſition, if therefore we ſubſtract 3 times the ſquare, 49 of 7 which is 147 from 324, the difference will be 177, and hence the work in the one will be to the work in the four, as 225 is to 177; or as 75 to 59; ſo that in reality the four require leſs work than the one; or at leaſt no more; becauſe the foundations ought to be conſidered.

There are other reaſons to prefer four dams of a leſs height to one of a greater. For it is not always practicable to make but one dam in a river, ſo as to keep up the water to a certain height above the camp. Since, if the ground is flat to a conſiderable diſtance, the water by overflowing will ſpread ſo much below, as to prevent its ri-

ſing

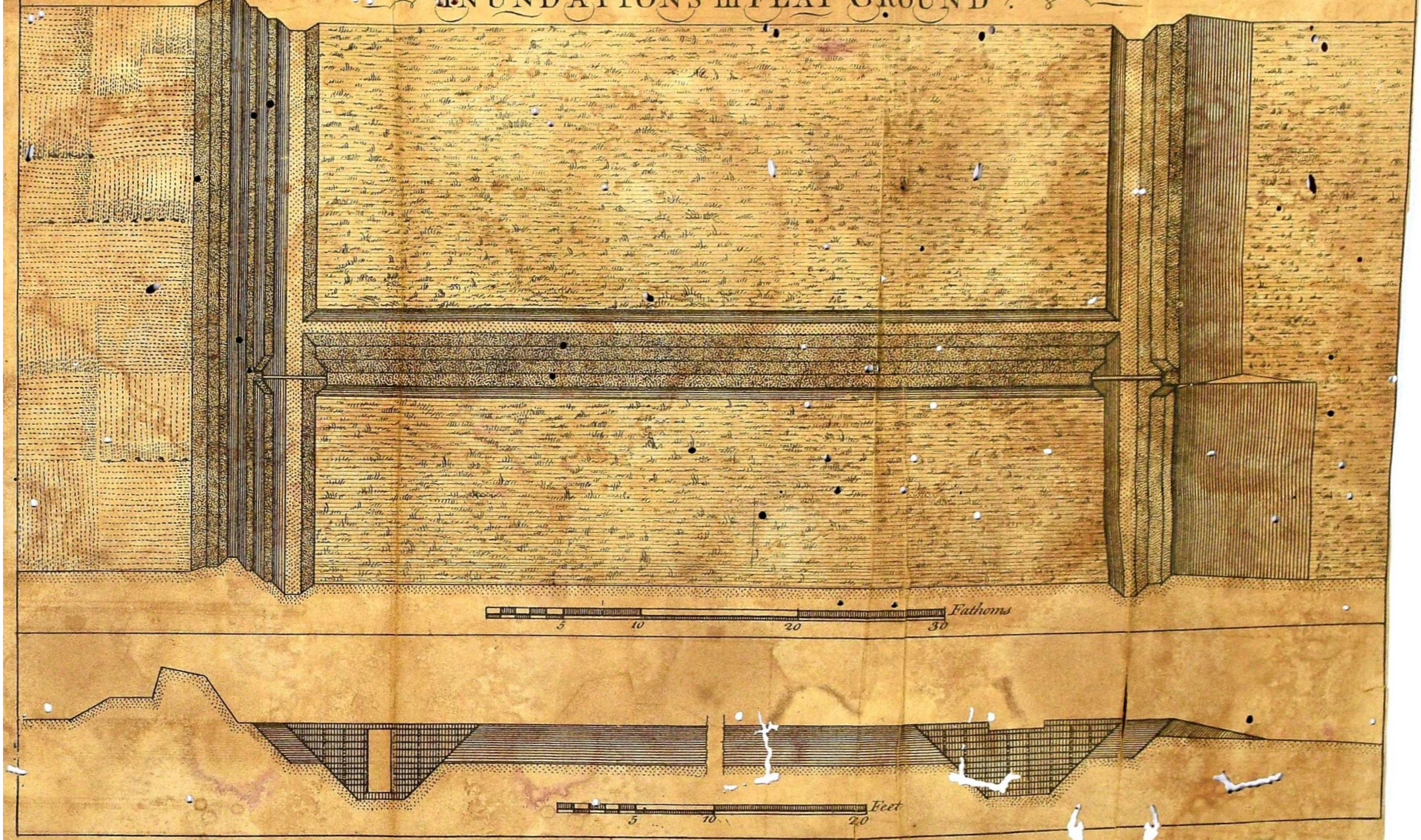
ſing above. Another diſadvantage attends a ſingle dam, that if it ſhould break either by a ſudden ſwelling of the water, or by the want of a ſufficient ſolidity, it will be much more difficult to repair it again, than any one of the four. In order to find the dimenſions of a profil of a dam, ſuppoſed to be of the ſame form as is repreſented by fig. 34, plate 19. of our elements of math. whoſe baſe of the ſlope being one fifth of the height, we muſt conſider, that common earth is nearly twice as heavy as common water, and by following the ſame ſteps as we did in art. 510; by ſuppoſing n=.2; and take w for the whole weight inſtead of two thirds, we ſhall find the thickneſs of the profil above to be .22 parts of the height. Thus if the height be 9 feet, then 9 times 22 gives 2 feet nearly; but if the height be 15 feet, then 15 times 22 gives 3.3 feet, or 3 feet 4 inches, for the thickneſs above; if to which we add 3 one fifth of the height 15, for the baſe of the ſlope, we get 6 feet 4 inches for the baſe of the profil. It is ſuppoſed, that the caſe of the dam is made with boards, ſtakes or faſcines, to prevent the water from waſhing away the earth.

The author reduces the difficulties of ſecuring lines by water to three, viz. when the low ground is of too great an extent, to form an inundation, to the great extent of the works which attends it; and when the deſcent

deſcent of the ſtream is ſo great as to require ſeveral dams to the number of poſts to be guarded. The two laſt of theſe inconveniencies have been mentioned already; and as to the firſt, if I underſtand him, is remedied in the following manner. If the flats are conſiderably extended, and a riſing ground terminates them, upon which the camp is ſuppoſed to be: he propoſes to make a ditch, from 15 to 28 feet broad, nearly parallel to the intrenchment; and another of the ſame width, parallel to and diſtant from it, from 40 to 60 fathoms: theſe two ditches are joined by others, nearly at right angles to them; and the earth taken out of them ſerve to form dams, by which the water is kept up to a proper height, in the ſame manner as thoſe deſcribed above do in the river: then he propoſes to make a kind of wooden ſluices with ſhutters, acroſs the two firſt ditches, where the dams meet them, to prevent the water from running out that way. This done, the lower ſluices are ſhut till the water is of a ſufficient height, then the next are ſhut, and ſo on to the laſt.

So far the ſubject is clear; but yet there remains one great difficulty in the execution, which the author does not ſo much as mention; all he ſays is, that the importance of ſecuring the entrance of the water into this baſon is ſelf evident: it appears to me, that the lower dam is what muſt be well ſecured, and

INUNDATIONS in FLAT GROUND



and not the entrance of the water; or elſe by cutting a paſſage through it, the water will run out of courſe. As to the guarding the entrance of the water it is not material when the inundation is once formed, which muſt be done before the enemy can prevent it, otherwiſe it is impoſſible to make ſuch a work when he is once near at hand; and to prevent the cutting the lower dam, I can ſee no other remedy, than to make it where the river runs ſo near the intrenchment, as to be defended from thence by cannon; for the defence of ſmall arms is inſufficient, ſince the enemy may bring a greater againſt it. Nothing more can be ſaid to it, than that a good engineer, who is upon the ſpot, may conſider, whether ſuch a ſcheme is practicable or not.

CHAPTER THE TENTH.

I. *Intrenchments to be made in caſe of a river.* II. *Plans of works to paſs it by open force.* III. *To repaſs it in the preſence of an enemy.* IV. *Another ſcheme.* V. *Example of the camp at* Nordheim. VI. *Precautions to be taken to prevent the paſſage of rivers.* VII. *Remarks on M.* de Folard's *epaulements.* VIII. *Continuation of theſe remarks, and ſchemes of the author.* IX. *Other ſchemes of M.* de Folard.

I. THE various operations a general may be obliged to undertake to paſs or repaſs a river, or diſpute the paſſage with an enemy, require the conſtruction of many different works, which ſhall be the ſubject of this chapter. Theſe works are ſeldom of ſo great extent, as to be ranked with lines, yet as their figure reſembles them more than any other, I thought they could not be better placed than following intrenchments covered by rivers or inundations.

I ſhall ſpeak of the works alone, avoiding as much as poſſible to enter into the various circumſtances relating to the motions of troops; in order not to depart from my ſubject, or to repeat without neceſſity what noted authors have wrote; for tho' ſcarcely any thing has appeared on the kind of fortification I have here undertaken, yet it is not the

the ſame with the other; ſince it has been ſo copiouſly treated, as to leave no room for any farther improvement.

II. When a river muſt be paſſed by open force, whether it be done by natural fords, or the means I ſhall ſpeak of have rendered it practicable, whether by boats, on floats, or ſwimming, it is always abſolutely neceſſary, that ſo ſoon as the firſt troops have paſſed over, and began to intrench themſelves, to make convenient and ſure communications.

If therefore bridges muſt be flung over; but if there was only one, a fort ſuch as we deſcribed in chapter 2d. will not be ſufficient, as not being large enough to contain the troops that muſt paſs; the firſt that arrive will be ſtraitened in the defence, or run the riſk of being taken off from the counterſcarp.

Beſides this work, which will be ſufficiently lined with eight men or leſs to a fathom, and where the reſt of the troops muſt file off, a ſpot of ground muſt be found where they can intrench or barricade themſelves, by fellings, or *Chevaux de Friſe*, as they arrive.

This halting place, I think, cannot be better placed than on the flanks of the intrenchment, which projecting beyond them will flank them; without this, they could not have too much depth; I think there cannot be leſs than 60 fathoms, that the troops may not be confuſed by thoſe who file off in their rear.

As these intrenchments extend in proportion to the numbers that enter, one of the extremities must be left open: M. *de Santa Cruz*, to remedy this, proposes to cross by branches the intrenchment down to the river at every 500 or 600 paces, or to supply this by a redout.

This precaution is exceeding good, but then the ground is broke, incumbered and diminished. If the river is narrow I think this additional work may be avoided, as the enemy will not be able to make an attac, without being flanked by the intrenchment on the opposite side, which before all things ought to be raised.

It is extremely necessary, if not indispensable, according to this judicious author, to construct a second bridge, when the first is finished, was it only to avoid the danger of having the communication of those that pass first cut off, if the artillery, or any other accident, should damage the first bridge.

XXVIII. The intrenchment, either entirely, or the greatest part, must be included, between the two heads; from thence results this great advantage, that if one of the bridges should be broke, the remainder of the army can march to support the work that covers it, and supposing the line finished, it is in no danger of being flanked.

The heads of the bridges have gates, because they must subsist some time, and must also communicate to the right and left, but none

none are made in the lines adjoining. When all the army, or at leaſt a number nearly equal to the enemy, have paſſed with the artillery, if they would advance, each battalion throws down the parapet and the counterſcarp before it into the ditch, ſo as to make an eaſy ſlope to march out in battle, and thus avoid the danger of filing off.

Thus we ſee what care and attention is neceſſary in ſo hazardous an enterpriſe; they muſt endeavour to deceive the enemy, to have time to raiſe the intrenchment and the batteries which defend the acceſs to the bridge; this intrenchment ſhould be favourably ſituated, either by ſuperiority of ground, or an elbow in the river, which helps to croſs the fires in front. *Laſtly*, the troops on the other ſide muſt work half at a time, each having his arms grounded two paces before him, and the other half, prepared for an engagement, muſt cover them: they ſhould relieve each other every hour, and if the enemy attac them before the parapets are formed, they muſt defend themſelves in the ditch, where they will be covered by the counterſcarp, and better aſſiſted by the fire on the other ſide, which by this means they will not intercept.

III. Of all military operations, perhaps the laſt is the moſt dangerous, excepting that of repaſſing rivers in the preſence of an enemy, where one part of the army is conſequently liable to be attacked in the rear, when the other cannot aſſiſt it.

 Few

Few authors have touched on this important subject: M. *de Feuquieres* would have the troops inclosed by good lines, whose extremities, supported by the river, are flanked by the fire of some large redouts on the opposite side; that the bridges, for he supposes many, and there cannot be too many in so critical a situation, that the bridges, I say, be covered by a second intrenchment, well lined with infantry; independent of this a redan, which serves to break up the bridge with security, as also to cover the rear of the retreat.

He also recommends these other precautions, which though they do not immediately belong to fortification, may here be of use: "The light and heavy baggage, says he, "should go before the army a considerable "time; the cavalry also before the infantry; "the first infantry that pass should be posted and intrenched on the other side, in "redouts, which should protect the flanks "of the army; nothing of this motion "should be seen by the enemy, that they "may not attac on the march, because "the disorder in such a case is to be dreaded; "and if the enemy are in sight of the camp, "the army must march in the night only; "but the second intrenchment, the redans "and redouts, must first be lined; and a "time chosen, when the enemy may not be "able to see the motion."

On these instructions, I shall propose the fol-

following plan, tho' I do not think myſelf obliged ſtrictly to follow them.

Theſe works incloſed one within another, and conſequently of different contents, are evidently deſigned that the troops, ſucceſſively retreating, may be ſufficient to line them, in proportion as their numbers decreaſe; for when there remains but ſix or eight battalions, it is certain they might be forced in that vaſt intrenchment, which contained the whole army; whereas they are in a ſtate to ſupport themſelves in the heads or lunettes of the bridges; but, I find the difference of extent between the line and theſe pieces too great for one intrenchment.

Suppoſing it neceſſary to repaſs a river, when one is not maſter of the other ſide; (which is rare, and ſuppoſes the enemy much ſuperior in numbers) to this difficult operation would be joined that of paſſing by open force; but as that is not the caſe here, the redouts M. *de Feuquieres* propoſes, are only proper to ſecure the heads of bridges againſt ſurpriſes, or the danger of being attacked, before being reinforced by ſome light troops: a ſingle line ought therefore to be preferred or added, becauſe ſuch a precaution is of uſe, which will form a communication from the right to the left, and flank with a greater fire every part within reach.

IV. I now come to the plan I mentioned, and which needs no deſcription, the plate being ſufficient to explain every thing. I Pl. XXIX.

ſuppoſe with M. *de Feuquieres*, that we are generally freed of all our baggage, and alſo whatever cavalry we think we ſhall not want, with the infantry to line the intrenchment on the other ſide, paſſed over; this infantry may be four battalions, I here ſuppoſe ſix.

If it is thought theſe detachments would weaken the army too much, the exterior line muſt be put into ſuch a ſtate of defence, as to ſupply this defect before they are ſent over.

This intrenchment and the works being finiſhed, the third line begins the retreat, followed by the ſecond, that is, by the reſt of the cavalry. The ſquadrons are divided into three detachments, and each detachment paſſes over the bridge neareſt to it.

This motion is made in the night, to keep it from the enemy's knowledge: yet if they ſhould diſcover it, and take that opportunity to attac, which they will do in the center, to avoid the fire of the intrenchment on the other ſide the river, the infantry at the extremities of the line ſeparated by the traverſing lines, muſt abandon that poſt, and replace that of the cavalry in the center.

But if all is quiet, theſe 12 battalions file off, four over each bridge: the ſix battalions in column begin their march, and are followed by the 24 others, one third over each bridge.

For greater ſecurity, theſe bodies may be removed alternatively, that is, from two take one, that the remaining by their extent may be

be able to line the parapet; they may even be doubled, the battalions being ſuppoſed here ſix deep.

At length only the redans and the intrenchments which ſupport them are occupied; they retreat from theſe, beginning by the intrenchments, and leaving in each redout within the bridge heads but two companies of grenadiers, who after having taken up or deſtroyed the bridges, retire in boats furniſhed with poles and oars, and drawn to the other ſide by two or three ropes faſtened to each.

Theſe redouts ſhould be formed, by two rows of pallifades, one foot diſtant from each other, and if it ſeems neceſſary, with a third row of inclined pallifades.

The troops, thus ſucceſſively occupying intrenchments proportioned to their numbers, are always able to line, and conſequently to defend them.

They will likewiſe be vigorouſly ſupported by the fire from the other ſide of the river, the batteries of which nearly flank the line, the traverſes and redans. Theſe laſt pieces, and redouts, are flanked as well by the ſix battalions, as thoſe who paſſed over, before it was neceſſary to defend them.

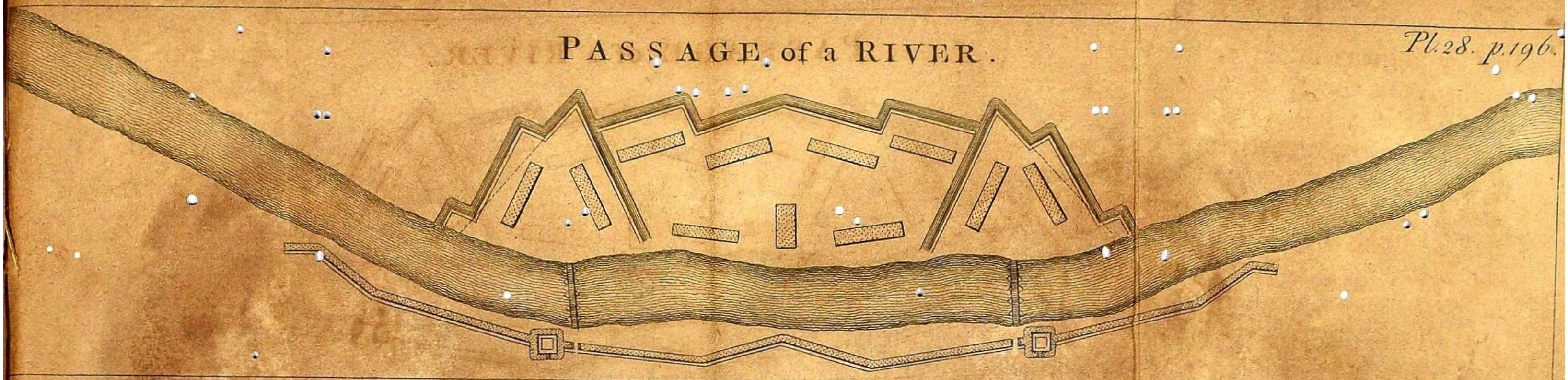
I traced the flanks and traverſes indented, that the cannon might flank them the better.

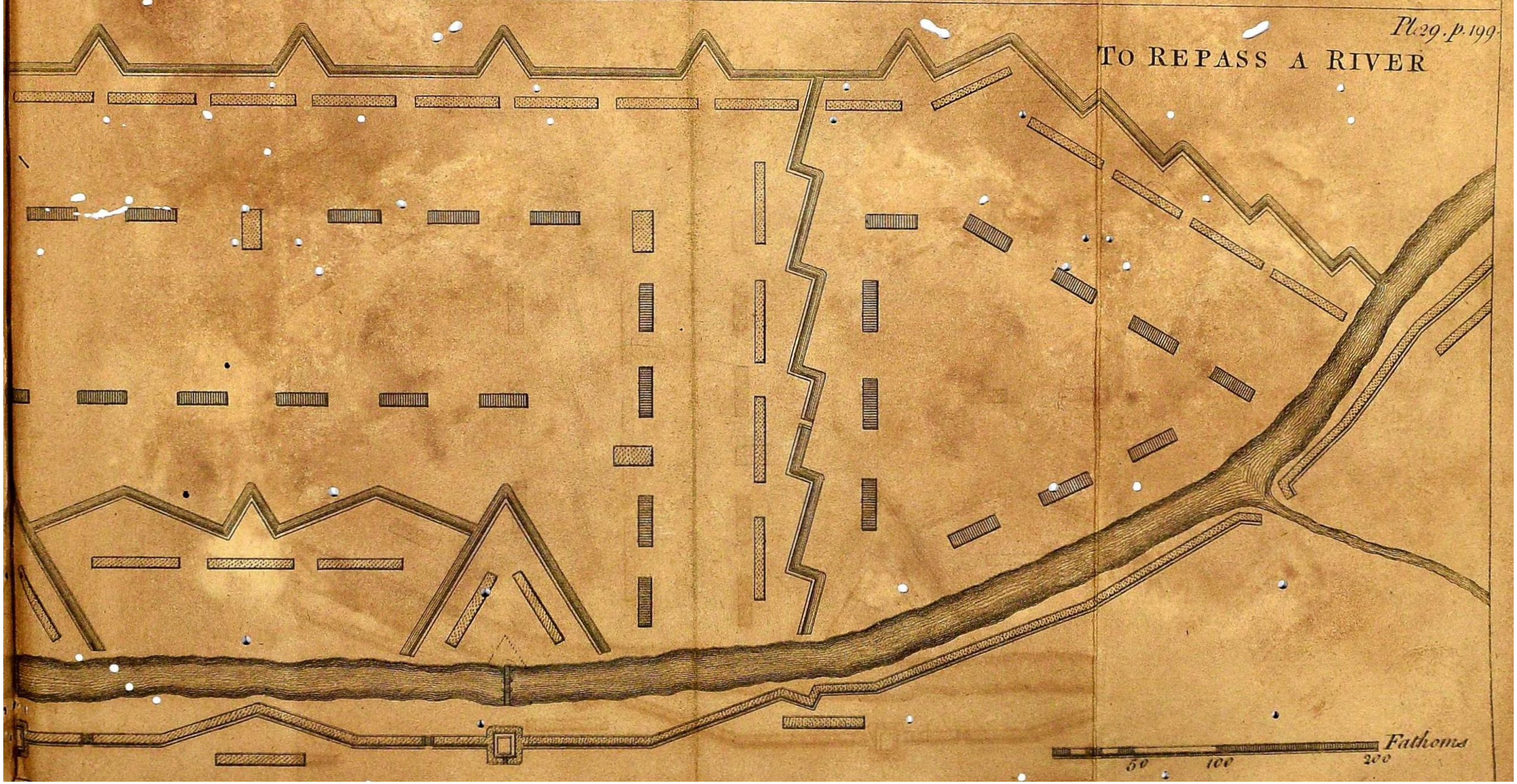
Tho' this camp only ſuppoſes 60 battalions, it would be ſufficient for fourſcore, by replacing the 24 ſquadrons of the ſecond line

line by ſo many infantry, from whence they might repaſs the river, as ſoon as the works ſhould be in a ſtate of defence; this cavalry ſhould poſt themſelves on the right and left of the exterior intrenchment, where they would be covered in front by the fire of the branches, and in flank by that of the oppoſite ſide; for greater precaution ſome redouts may be thrown up there.

If this ſcheme is objected to, as requiring too much work, I anſwer, that the ſafety of the army requires it, and nothing but tools are wanting, for there are more troops than needful to execute it in a very little time, and without diſplacing them. As to the intrenchments on the other ſide the river, if the banks on both ſides are on a level, or that on the oppoſite ſide high, it is ſufficient to ſink it in the form of a trench, by throwing the earth on the outſide, which will ſhorten the work. In whatever manner it is done, we muſt always begin at the extremities, becauſe theſe parts being deſigned to defend the flank of the exterior line, will be moſt wanted. As to the batteries, ſo far from being ſunk, they muſt be raiſed and placed ſo as to command at a diſtance in front.

V. The method the prince of *Conti* took to repaſs the *Rhine*, in 1741, with the army under his command, is ſo good an example, that I ſhould have nothing more to propoſe, were circumſtances always the ſame. The following is a relation of the principal circumſtances


PASSAGE of a RIVER.
Pl.28. p.196.


Pl.29. p.199.
TO REPASS A RIVER
Fathoms
50
100
200

cumſtances of this event, drawn up by the chevalier *de Clairac*, my nephew, who was preſent.

The right wing of our army, ſupported by the rivulet and moraſs of *Hoffeim*, was covered by redans, each large enough to contain one battalion; we alſo poſſeſſed the village of *Bobſtat*, within reach of which were the only openings by which the enemy could enter the plains. Pl. XXX.

The left, ſupported by impracticable moraſſes, and covered by the little river of *Weiſchnitz*, was only acceſſible by the cauſeway and bridge of *Wattenheim*, a large village towards the extremity of the line.

While the redans on the right, and ſome others towards *Bobſtat* were raiſing, we conſtructed five redouts at ſome diſtance from the tails of the two bridges we had flung over below *Rindurkeim*. Theſe redouts were ſo ſituated, that the enemy could not penetrate until they had forced them all; which was the more difficult and tedious to be done, as being well guarded, they reciprocally defended each other, and could not be attacked but one after another.

All our baggage being ſent over the *Rhine*, and the works finiſhed the day following at break of day, ſome troops of cavalry, one regiment of huſſars, and the independant companies were drawn up between *Bobſtat* and the rivulet, and the infantry brigade of *Britany*, deſigned for the rear-guard, were poſted

posted in the hedges beyond *Nordheim*, after which the army, being drawn up at the head of the camp before day, began to file off in five columns, three of infantry by battalions in front, and two of cavalry; the artillery, divided into four parts, were in the intervals.

The troops which guarded the openings of *Bobstat*, being on their march, were attacked by 6000 hussars, croats, or pandours, commanded by general *Trips*, who made some squadrons give way, and falling on the rest, put them into disorder; but the whole quickly rallied behind a reinforcement of cavalry, sent from the main body, who having stopped the enemy, rejoined their column.

They were yet more unlucky on the right. Those who passed by *Wattenheim* were vigorously repulsed before *Nordheim*, and the enemy resolutely followed the troops who retired from this post, till the fire of the first redouts stopped them, and the brigade of *Britany*, facing quickly to the right about, pursued them close with fixed bayonets, and drove them back to the very village.

In the mean time the army filed off leisurely; when the main body and artillery had passed the *Rhine*, the rear-guard, and those of the redouts, which we successively evacuated, followed.

We had no more than 15 companies of grenadiers to line the intrenchments of the

tails

tails of the bridges. They all came over except 100 men, who ſtaid while the bridges were taken up, which was done ſo haſtily, that the violence of the wind and current having broke the cables, we were obliged to burn ſome of the boats.

The bridges being at ſome diſtance from the ſhore, the 100 men ſet fire to a heap of faſcines and tarred wood, which ſerving as a ſhelter, gave time to this little body to embark in the boats which waited for them.

This famous retreat, made in eight hours, without the leaſt confuſion, coſt us no more than 200 men, killed, wounded and priſoners, and the enemy loſt above a thouſand.

There are not I believe many examples of paſſing an army over ſuch a river as the *Rhine*, in broad day, with ſo much order, and ſo little loſs, eſpecially being purſued by a conſiderable army compoſed in part of light reſolute troops. The choice of a camp, the poſſeſſing of all the advantageous poſts, the diſpoſition of the troops, always within reach to ſupport each other; the artillery, redouts and works, in ſhort the detail of many other circumſtances not belonging to the preſent ſubject, prevents my ſaying any thing more of ſo ſkillful a general.

The five redouts, capable by their poſition to cover a numerous body, have in ſome meaſure the ſame effect as my exterior line. The bridges were covered by one work only, yet the ſize and figure alſo anſwered the intent

tent of the two redans and the intermediate intrenchment. The curtain was broken, because the ſaliant parts were ſo far diſtant from each other, as to require theſe new flanks; laſtly, two batteries on the oppoſite bank defended the acceſs to this head.

Theſe works, much leſs conſiderable by their extent, than by their judicious diſpoſition, were ſufficient to ſecure the retreat of a good army, well conducted, full of confidence and courage, ſo that any additional works would have been ſuperfluous; but if I may ſpeak my mind, I believe M. *de Artus* who directed them, would not have thought them ſo, with an army that had been beaten, diſcouraged, and where conſequently, it is to be feared, the moſt exact order is not maintained; in this caſe I think my ſcheme more agreeable.

VI. Having treated of paſſing rivers, I might be accuſed of neglect, if I ſaid nothing of the means of preventing theſe paſſages.

Is it not a paradox to aſſert, that this operation is as difficult as the other? Yet it is true, if not in itſelf, at leaſt by circumſtances. Nothing is more difficult than to paſs when an intelligent enemy oppoſes the paſſage; it is even impoſſible, if they lodge firſt on one of the banks; yet nothing is more difficult than to hinder the paſſage, when there are many fords, or places where bridges can be flung over; becauſe to guard theſe places reduces an army to nothing; and in this caſe,

as

as *Feuquieres* obſerves, " the general, who extends his army, has the leaſt proſpect of ſucceeding."

The beſt to be done on this occaſion, I think, is to throw up ſmall redouts, not only in the ſuſpected places, but in their intervals, and near enough each other to form a chain of centinels and patroles, and if the country is on our ſide, fifteen peaſants is ſufficient for each, who by theſe works will not be in danger of being ſurprized in the night, by parties who might croſs in boats; when they diſcover any extraordinary motion, they make an appointed ſignal, which being repeated from poſt to poſt, paſſes in a moment from right to left, time enough for the adjacent troops to arrive: this I ſaw practis'd in *Alſace* during the laſt two wars.

When there is an iſland within reach, it muſt have troops poſted in it, and ſome works to cover them; at leaſt, all the wood and buſhes ſhould be cut down, that nothing may paſs unſeen. Had we taken this precaution at *Spire* in 1735, the imperialiſts could not have burnt our magazines, cloſe to the gate of the town, with bombs and hot bullets, which by good luck were not conſiderable.

In preſcribing theſe precautions, I ſuppoſed a deep river; but when it is not ſo every where, the fordable parts ſhould be obſtructed by every method that can be deviſed. If in either caſe there are but

few acceſſible places, intrenchments muſt be raiſed on the bank before them, that the troops which march on the ſignal given, may enter them at their arrival.

Theſe intrenchments always uſeful, are often abſolutely neceſſary; for if the enemy come with a conſiderable artillery at the ſame time with your troops, it is probable, that not being able to ſuſtain the enemy's fire without theſe intrenchments, they will be quickly obliged to quit the ſpot.

VII. There are ſo few ſchemes of this nature to quote, that it would be an affectation to paſs by thoſe M. *de Folard* has propoſed on this ſubject, tho' the firſt does not appear to me clearly expreſſed.

" The beſt way, ſays he, is to make ſtrong " epaulements, in the form of a creſcent or " curve, at 80 or 100 fathoms from the place " where it is thought the enemy can paſs; " the two horns or extremities of the curve " muſt be 20 fathoms from the ſide of the " river, that they may not be enfiladed by " the enemy's cannon, and that there may " be room enough on the outſide to cover " a great body of cavalry and infantry. " This epaulement ſhould be 7 or 8 feet " high, the earth caſt towards the enemy, " as we make our trenches, and it muſt " have a gentle ſlope; it is behind this little " hillock of earth, covered from the fury of " the enemy's cannon, that we wait at the " paſs."

When

When a certain number of the enemy are paſſed, and they begin to form in ſpite of this croſs fire, which, as the author obſerves, will rake them in front and flank, "the "cavalry mount their horſes, and march "towards the enemy, with a grenadier be-"hind each, whom they ſet down, when "within a certain diſtance, to form pla-"toons of 50 grenadiers each, who are to "engage with them, between the ſqua-"drons."

This laſt paſſage I do not well underſtand; it may be want of conception on my part; tho' it would not be aſtoniſhing, if in ſo great a work, and wrote with ſo much ſpirit, an author full of his ſubject, ſhould not be equally intelligible throughout.

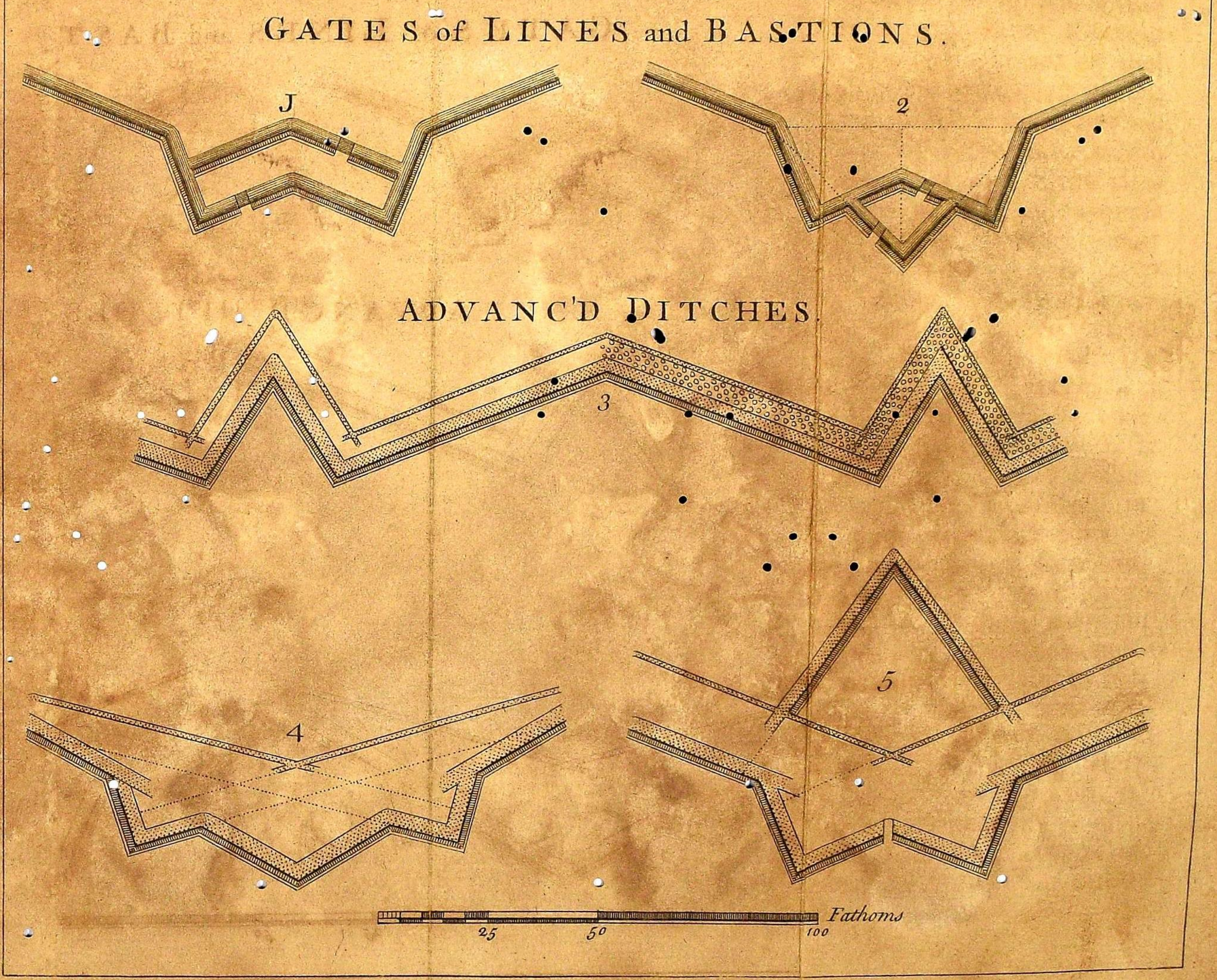
The figure ſo far from explaining, rather confuſes me the more, by the ſmall depth of the intrenchment, in reſpect to the number of troops drawn up there, if I was not aſſured, that the ſame plate ſerves for two different examples.

I have nothing more to add on this, only that the depth of the curve being determined at 80, or 100 fathoms, it will be ſtraiter in proportion to the greater body to be covered without, and the ſtraiter it is, the leſs it will flank the enemy; finally, ſuppoſing even the figure eliptick, the center will only be defended in front by ſmall arms, if the greater axis exceeds 240 fathoms, that is double the range of a muſket.

The gentle ſlope of the epaulement, ſhews plainly that the troops are to mount by that to attack, which is an excellent thought at leaſt for the infantry, as they can make it from every part at once, and there will be one part covered by the fire of the oppoſite ſide, againſt that of the enemy; but in this caſe, of what uſe are the paſſages of 20 fathoms at the ſide of the river? finally, if the troops behind the epaulement, are deſigned to cover them, what neceſſity is there for advancing with the grenadiers mounted for ſo ſhort a diſtance? it cannot be thoſe he means, but others who are to march in order to reinforce them.

I muſt yet add, that it is not my fault, if I cannot give a better explanation, having applied to the author for that purpoſe, but after waiting a long time, without receiving the explication which he promiſed me, I was obliged to go without it. I ſay this in my own juſtification; for in my opinion, it is unpardonable to quote obſcure paſſages, and complain of their obſcurity, when by writing, or ſpeaking to the author, it is eaſy to have them explained.

VIII. I ſhould not be much more excuſable, for referring to ideas, which I look on as imperfectly expreſſed, if I did not, in ſo doing, draw the advantages the author propoſed; and which perhaps I might find there, if I underſtood them better.


GATES of LINES and BASTIONS.
1
2
ADVANC'D DITCHES.
3
4
5
Fathoms
25
50
100

The following method I think anſwers his deſigns; the curve figure propos'd, tho' little practis'd, is convenient, but it requires attention and choice. The more the curve approaches to a ſtrait line, the eaſier it is to conform to an eſſential maxim of his, which is, that the exterior be covered throughout: beſides the order of battle will be leſs broke, the front of the troops which muſt line it approaching the nearer to a right line.

The elipſis muſt therefore be rejected, as having parts where the curve is too abrupt; and for a much better reaſon the ſemi-circle, which beſides that inconvenience, cannot be formed with a radius of 80 or 100 fathoms, (the ſmalleſt range of a muſket,) as the epaulement would not have extent enough.

The firſt ſcheme is conſtructed on theſe principles: it is the ſegment of a circle of 128 fathoms radius, and 80 fathoms for its verſed ſine, which determines the chord at little more than 226 fathoms. Pl. XXXI. Fig. 1.

This method is good, as the fires drawing nearer together, in proportion to the diſtance from the circumference, and ſo muſt have a great effect, as well on thoſe that have paſſed, as on thoſe that are paſſing; but it is not eaſy in practice to trace the portions of ſo great a circle.

For that reaſon, perhaps the ſecond figure may be preferred: the opening is 240 fathoms; the middle line 60 fathoms long, Pl. XXXI. Fig. 2.

 parallel

parallel to the river, and 80 fathoms diſtant from it.

This line and thoſe of the ſides being ſtrait, the fires of each are parallel between themſelves, but they croſs a conſiderable ſpace, (when thoſe of the firſt plan, in the ſegment of the circle, approach and unite) which may be thought more advantageous.

Pl. XXXI. Fig. 3. If that is not approved of, the circular form may be approached at pleaſure, by dividing the chord into as many parts as the figure is to have ſides, and determining the length of the perpendiculars either by computation or by the ſcale.

Which ever method is followed, the moſt eſſential point is to cover the exterior part of the work, ſo as not to be ſeen from the oppoſite ſide of the river, which will be at leaſt 400 fathoms diſtant from it, this is ſufficient in reſpect to the range of field pieces, and the uncertainty of firing at ſo great a diſtance.

This cannot be done but by epaulements, whoſe length will depend on the figure of the courſe of the river; if it forms a rentrant towards you, they will be ſhorter, if the elbow runs from you, they become larger, we here ſuppoſe the courſe in a right line.

Theſe epaulements muſt be ſo diſpoſed, that the troops may move eaſily behind the extremities of the work, that the files of troops be not ſquare with their front. It is on this maxim, that in the laſt plan I made

made them perpendicular to the ſides. The hook parallel to the river, and alſo the adjacent parts on the right and left, are deſigned for artillery, which batters the acceſs and the paſſage of the river, and the enemy's cannon almoſt directly.

There only remains one obſervation more to make, it is on the profil of this work. Theſe gentle ſlopes, that the cavalry may aſcend and deſcend, (which I believe is the meaning of the author,) would be very advantageous to draw out in line of battle; but their conſtruction will be found very difficult, if ſeven feet and a half are given for the height of the epaulement, as they muſt have at leaſt 30 feet baſe, which added to the thickneſs at top, makes at leaſt 11 fathoms at the bottom, and ſeven fathoms and a half ſolidity in every fathom length; but independant of this exceſſive work, it is plain what trouble there will be, in throwing the earth ſo far, eſpecially taking it only from one ſide, and how much the ditch adds to this diſtance and the length of the ſlope; beſides it is obvious that the leaſt rain renders ſuch a paſſage abſolutely impracticable.

The whole is remedied thus; let the part of the epaulement deſigned for cavalry have only the natural ſlope, that is a gradual one, with one or two openings of 36 feet each, and maſked at an equal or proportioned diſtance, which will ſerve as a paſſage.

The epaulement for the infantry 6 feet

 high

high, and its ſlope, one foot and a half to a foot, that the battalions may leap over, without filing off.

Thus in one caſe, there will be about half, and in the other two thirds leſs earth to remove, and it is taken within and without, which greatly ſhortens the work, obſerving to make the excavation as broad as poſſible, that it may have the leſs depth.

The epaulements of the flanks will better guard againſt the ricochet, if we give them the height of the firſt profil, when the infantry are on the ſides. They cannot be leſs than 8 feet high to cover a man on horſeback, ſuppoſed on a level with the enemy, as I do here, and which without doubt ſhould be taken as a rule.

IX. *Folard*'s other ſchemes relate to thoſe elbows, or turnings in a river, where the defendants cannot engage, without being taken, or battered in front, flank, and ſometimes in the rear. They give the enemy great advantage, no doubt; but to uſe the author's own words, not ſo much as is commonly ſaid; for theſe windings are, at leaſt in part of their extent, enfiladed, and ſeen obliquely from the points where the curve begins.

To gain by this circumſtance, he raiſes a redout at each of theſe places, capable of containing 150 men with cannon; the reſt depends on the number of troops that may be thought neceſſary to ſuſtain the poſt.

Pl. XXXI. Fig. 3. If there be a body of cavalry and infantry within

within reach, conſiderable enough to charge thoſe who may endeavour to force it, they are ſheltered from the enemy's cannon, by joining epaulements to theſe works, of the kind we have ſpoken of, as it is pricked on the figure.

But if there is only infantry, and the number of theſe windings does not permit to employ ſufficient forces at each, a line muſt be drawn from one redout to another, the middle of which is covered by a lunette, to which it communicates.

Finally, if the redouts can only be guarded, they muſt be ſo conſtructed, palliſaded, and defended, as at leaſt to hold out till ſuccours can arrive; the ſame muſt be underſtood of the lunette and intrenchment.

I thought to flank theſe redouts, and to turn them and the line which joins them, in a manner moſt proper to have fulfilled their deſign; but it is in that only, I here differ from M. *de Folard*. We muſt obſerve, that in this, and the preceding article, he ſuppoſes the river fordable; for if it was not, leſs work would ſuffice to hinder a bridge being thrown over. His epaulements are yet very proper for this uſe, ſince if the bridge was finiſhed, it would be uſeleſs, on account of the facility of ſucceſſively beating the troops that might endeavour to paſs.

OBSERVATIONS on the tenth chapter.

The manner of paſſing rivers, when an enemy is at hand or preventing an enemy from

from paſſing, is certainly a maſter-piece of the art of war: it is what authors treat with the greateſt care, and in the fulleſt manner, eſpecially M. *Folard*, in his commentaries upon *Polybius*, vol. 4. And our author has taken great pains to explain it by the help of ſeveral draughts: the firſt plate 28, contains two bridge-heads joined by an indented retrenchment, wherein all the parts are well flanked; this example ſuppoſes an army to paſs a river, when the enemy is on the ſame ſide; and as a part paſſes the others retire gradually from the retrenchment into the lunettes, which cover the bridges; and thoſe who have croſſed firſt intrench themſelves, in order to cover the retreat of the laſt.

The example in plate 29, ſuppoſes a large army, which is not only intrenched all round from one end of the river to the other, but a part is cut off on each ſide by an indented retrenchment; in order, when part of the army has croſſed, the reſt not being ſufficient to line the whole work, that they may retire in the middle part; and as the number diminiſhes into that part between the bridge-heads, and from thence into the lunettes which cover the bridges, whilſt thoſe on the oppoſite ſhore intrench themſelves, in order to cover the retreat; but to ſecure the retreat of the laſt, ſmall redouts are made with a double row of palliſades, within the lunettes, in each of which two companies of grenadiers are left; and as ſoon as the bridge is

broke

broke up retire in boats, which are partly towed over with ropes, and partly by rowing. It is very certain, that this paſſage is as well covered as can be expected; and if the troops do their duty without confuſion, it will be a difficult matter for the enemy to break in upon them, tho' equal in number. It muſt however be obſerved, that the ground muſt be level all round this intrenchment for 7 or 800 fathoms diſtant; otherwiſe the enemy's cannon, placed on a riſing ground, would do great execution, and conſequently diſturb the retreat greatly; for which reaſon it would be very hazardous to undertake the paſſage in ſuch a caſe; unleſs the cannon could be maſk-ed by a high epaulement; or having a large battery on the oppoſite ſhore to oppoſe an equal or ſuperior fire to them.

The author's next example, relating to the retreat of the *French* over the *Rhine* in the face of the *Auſtrian* army, by prince *Conti*, is perhaps one of the fineſt that was made this age: as the author gives a very particular account of it, we ſhall paſs to the next repreſented in plate 31, which he has taken from Mr. *Fo-lard's* notes upon *Polybius*; the queſtion is here to prevent an enemy from croſſing a ri-ver before your face, and with open force. The beſt way, ſays Mr. *Folard*, is to make a ſtrong epaulement in the form of a creſcent or curve line, at 80 or 100 fathoms from the place where the enemy is ſuſpected to paſs, the ends ſhould terminate within 20 fathoms

of

of the ſhore, ſo as not to be enfiladed by the enemy's cannon, and the intrenchment ſhould be large enough to cover a great body of horſe and foot: this epaulement ought to be 7 or 8 feet high, and the earth thrown towards the enemy. This our author thinks is obſcurely expreſſed, eſpecially where Mr. *Folard* adds, when a certain number of the enemy have paſſed, and begin to form, the cavalry mount, and each takes a grenadier behind him, in order to form platoons between the horſe. For, ſays he, what reaſon is there for mounting grenadiers for ſo ſmall a diſtance? If I am not miſtaken, Mr. *Folard*'s reaſon was, that as ſoon as the enemy begins to form, no time ſhould be loſt, for fear that they might make too great reſiſtance when once formed; for which reaſon the horſe is to charge firſt, paſſing thro' the openings left near the ſhore, and which he expreſsly ſuppoſes not to be enfiladed; and as horſe alone is not ſufficient to break the infantry, he makes each horſeman take a grenadier behind him, in order to form platoons, to aſſiſt the horſe till the infantry can come up and aſſiſt them; ſo that the obſcurity our author complains of, is not *Folard*'s fault.

He complains likewiſe that the retrenchment appears too ſmall for placing ſo many troops behind it; without conſidering it is done for a very ſubſtantial reaſon: which is, to leave as little ground for the enemy's forming in order of battle, and to defend the croſ-

ſing

ſing of the river more vigorouſly, both by ſmall arms and cannon; which could not be done ſo well at a greater diſtance than a 100 fathoms. Neither is there any want of room behind, for placing as many troops as is required; ſince under the cover of ſo high an epaulement, they may be drawn up in columns, as Mr. *Folard* would have them to fight; beſides, no ſpot of ground is every where on a level, and the leaſt bank or valley is ſufficient to cover more. It is plain, that the chief intent of this work is to defend the river at as near a diſtance as poſſible, and therefore any other poſition farther off would not anſwer the author's intention. The author makes a ſuppoſition, which common ſenſe ſhould have convinced him could not have been thought of; which is, that the eaſy ſlope made to the intrenchment was deſigned for horſe and foot to march over the retrenchment in order of battle. Upon this ſuppoſion he gives a long detail of the quantity of earth to be thrown up, and then ſays, that the leaſt rainy weather would waſh off the parapet in a ſhort time. Another very uſeleſs inquiry is made, concerning the nature of the curve line, which is moſt proper for the retrenchment, he rejects the ellipſis, and the ſemi-circle, and therefore ſuppoſes it muſt be an arc only; but a circular arc of ſo great an extent being not eaſily traced, he makes them in parts of right lines joined together. It is ſomewhat particular, that he ſhould imagine,

that

that the curve muſt be a geometrical one: for in practice, works ought to be traced without inſtruments, and at firſt ſight; and it is not material what that curve may be, or whether quite regular or not, provided it anſwers the purpoſe it is ſufficient; beſides, the nature of the ground may be ſuch, that a ſtrict regularity could not be obſerved, as to the works, which our author makes at the flanks, they may be very uſeful, in caſe the enemy can flank the retrenchment.

He ſuppoſes, with Mr. *Folard*, that the inward bent towards the enemy of the river is not ſo advantageous in paſſing the river as is generally imagined. Whatever theſe authors may think, or ſay, it may be aſſerted, for truth, that no better place can be fixed upon than that; for they pretend, that at the extremity of this bent their paſſage may be enfiladed, by redouts placed on the oppoſite ſhore; but will theſe redouts enfilade the bridge, where the river runs from the inward bent in a ſtrait line, as the author ſuppoſes in the third figure, plate 31? this may be the caſe of one in a thouſand, and therefore not to be mentioned; but for example, ſuppoſe the ſituation was ſuch; what advantage can be taken? theſe redouts, being cloſe to the ſhore, can the enemy not erect a battery on the oppoſite ſide of as many cannon as he pleaſes, and ſoon deſtroy it; or at leaſt draw the fire towards this battery, and abandon the bridge? ſo that, unleſs

it

it is ſuppoſed that the enemy has no guns, which is abſurd, and the objection frivolous.

On the other hand, ſuppoſe the bent was from the enemy, Would not the bridge, and all the works made to ſupport the paſſage, be enfiladed from every ſpot of ground on the other ſide? Would not then a general be highly blameable to attempt the paſſage of a river in ſuch a place? If the river was ſtrait, how would it be poſſible to defend the paſſage with any advantage, which the oppoſite army has not, even ſuppoſe a ſingle redan was made to cover the bridge, before any troops appear to oppoſe them? After as many troops are paſſed as the lunette can hold, How could they propoſe to march out upon a ſmall front, to recieve an enemy, who is ready and prepared to receive them, as ſoon as he arrives, before the batteries on the oppoſite ſhore can in that caſe fire upon the enemy without hurting their own troops?

It is true, the enemy may be deceived by feint marches, ſo far as to get to the place deſigned for the paſſage ſome few hours before him; but as ſoon as he is come up, has it in his power to raiſe batteries for batteries, and by that means fall upon thoſe that have paſſed firſt with all his force, without any fear of the oppoſite guns.

It may then be concluded, upon unanſwerable reaſons, that no better ſpot of ground can be found for paſſing a river, either

either by main force, or by ſtratagem, than at an inward bent of the river.

When the river may be forded in ſeveral diſtant places, Mr. *Folard* propoſes to deſtroy them, or render them uſeleſs, by felling trees on the oppoſite ſide, to make holes, ditches, inundations, or to throw a great number of crows feet, or planks full of iron points, or, if poſſible, to throw a great many trees in them with their branches, ſo as to ſtop the current, and make the water ſwell, ſo as to render the paſſage impracticable without a bridge. Thoſe who are deſirous to know more of this ſubject, may conſult his fourth and fifth volume upon *Polybius*.

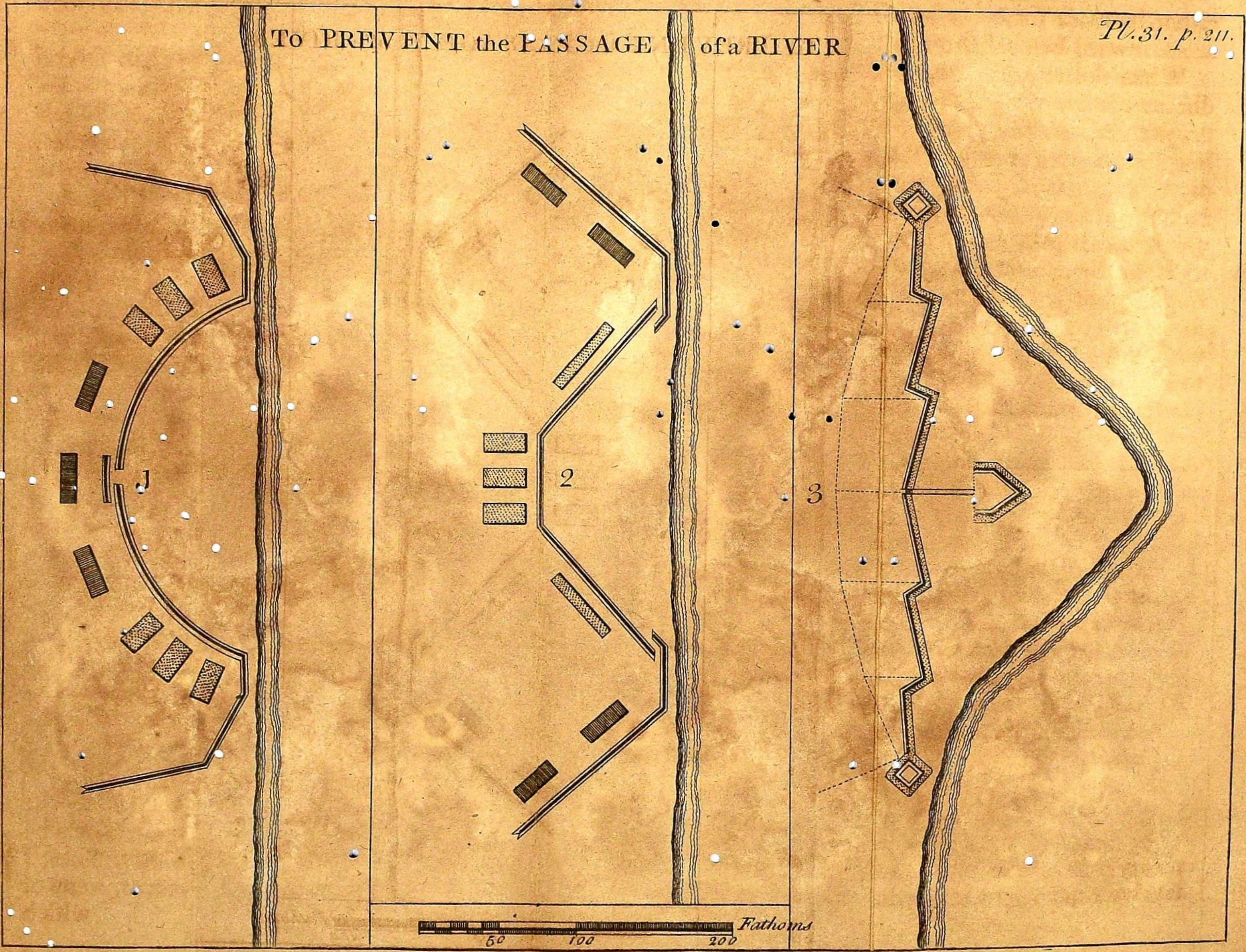
CHAP. XI.

I. *Gates.* II. *Communications.* III. *Platforms.* IV. *Epaulements for cavalry.* V. *Schemes of intrenched epaulements.* VI. *Bog-houſes.* VII. *Manner of covering the gates of common lines.* VIII. *Covering thoſe of the different kinds of lines propoſed.* IX. *Advanced ditches; their advantages.* X. *Ravelins.*

I. I Shall henceforth comprehend under the name of lines all kinds of intrenchments that can be applied to them: lines, I ſay, have occaſion for certain works, ſome of

which

To PREVENT the PASSAGE of a RIVER



which facilitate the neceſſary movements, and others contribute to the ſecurity and convenience of the camp : ſuch are gates, interior communications, platforms for cannon, epaulements for cavalry, and bog-houſes.

The number of gates to be made in lines depends on the number of troops deſtin'd for their defence, the deſign of the general, and the nature of the adjacent ground.

There were but few gates in the lines of *Philipſburg* in 1734, and they were no larger than thoſe in the places of arms of a covert-way. The reaſon of this was I ſuppoſe, that our cavalry being ſent back for want of ſubſiſtence, to the other ſide the *Rhine*, weakened us greatly ; and that we had a numerous army before us, that the taking of the place was our ſole object, as it was ſo immediately neceſſary, to prevent the overflowing of the water, which would have deprived us of all communication from one ſide to the other.

We may alſo uſe them for thoſe lines, which are only acceſſible by few roads, or for thoſe, before which there is not ground enough to draw up ; but theſe different caſes are exceptions to this rule.

We cannot in general have too many paſſages, as they are neceſſary in advancing or retreating ; they are, as in chap 5, the only means of abridging the time loſt in filing off, and conſequently of removing the defect M. *de Feuquiers* has ſo juſtly remarked.

Another

Another motive, no leſs important, ſhould determine us to this; tho' the enemy, maſters of the parapet, leap over in ſome places, while the body of men at a diſtance advance to charge them, a ſally of ſome choice troops, made briſkly from right and left, and at a ſmall diſtance from the part attacked, is, as M. *de Santa Cruz*, and *de Folard* remark, one of the beſt motions that can be made; but to do this the barriers muſt not be too far diſtant from each other. M. *Vauban* in his treatiſe of the attac of places, allows 22 feet for the width of theſe gates; he prefers the placing them in the high roads or in the middle of the curtains, or near it, and covers them as we ſhall ſhew hereafter,

What he allows for lines of circumvallation, is equally proper for thoſe we are ſpeaking of; the paſſage is thus wide enough for the cavalry to file off by fours, and the infantry by eight: certainly a beaten road is preferable to a new one, and the paſſage cannot be better placed, than in the part the beſt flanked.

II. One point this illuſtrious engineer inſiſts on, is that of a communication; there are few places that are not ſituated on rivers ſmall or large, which conſequently cuts the beſiegers lines into two. The kind of camps we are ſpeaking of, are not ſo frequent in this caſe, but it may happen; and beſides, we commonly find rivulets, ditches, fenny grounds hollow ways and thickets.

Every

Every thing that may hinder, or retard the aſſiſtance, that one part ſhould give another, is ſo eſſential an inconvenience, that in the words of that author *, the ſafety of an army may depend on it; we cannot therefore be too attentive to this point.

If the right is ſeparated from the left by a river †, he would have three or four bridges conſtructed, each 4 or 5 fathoms broad, and 50 or 60 fathoms diſtant from each other, to avoid confuſion, and their extremities defended and covered by redans.

This I believe can be beſt done by boats, in regard to their length; but if the bridges be on truſſes, which he prefers, as being more firm, and leſs liable to diſorder, I don't know if, according to *Folard*, it would not be better, that they were broad enough to paſs over by diviſions at leaſt; for, ſays he, "it does not "require more time or trouble to make "one paſſage, or a bridge of 100, or 120 "feet broad, than ſeveral of 13, or 15." This is undeniable, and it is certain that more can paſs over one bridge of 120 feet broad at once, than over four of 30; as theſe narrow bridges often oblige the column to halt, while the head paſſes over: in ſhort, the more there are together, the ſtronger and in better ſtate they are to charge, after their paſſage.

Which ever method we take, if the camp is cut by rivulets, ditches or hollow ways,

* Memoire pour la conduite des ſieges. *Vauban.*

† Traitè de l'attaque des places. *Ibid.*

we practice the ſame as for rivers, where we make the ſlopes broad and gentle enough for cannon and cavalry to paſs eaſily: if any part is marſhy, cauſeways are formed, of the ſame breadth as the bridges.

The buſhes, brambles and thickets, which may be found near the intrenchment at the rear of the camp, muſt be cut down cloſe, that the horſes may not ſtumble over the ſtumps; finally omitting nothing in ſo important an article, multiplying the bridges, and other means, in proportion as we can ſpare time and workmen.

III. Platforms for cannon are made at the ſame time with the line; they are commonly in the moſt ſaliant parts, that is to ſay, in the flanked angles, where there is always more earth than neceſſary; by this poſition their fires croſs the better, and reach the farther.

Theſe platforms are raiſed to 2 feet below the crown of the parapet; if the excavation of the rounding of the ditch does not furniſh earth enough to make them ſo large as needful, and to form the ramps, or ſlopes, the officer of the artillery, whom this more particularly regards, finiſhes them with his own men.

IV. The author I juſt now quoted, mentions epaulements to cover cavalry, as a precaution that has been neglected theſe 50 or 60 years paſt; he does not ſay why the practice ceaſed, but perhaps it was becauſe of the ſhort duration of moſt ſieges; whatever was the

the reaſon, as he propoſes them in countervallations, I may be permitted to give my opinion.

When we attac lines in broad day, we commonly cannonade them for many hours, before we attempt to force them, then in whatever manner the infantry is diſpoſed, the parapet muſt be very low, and very bad, if it does not cover them and the cavalry, (that the body which ſhould engage the laſt, and behind which the others ſhould rally in caſe of need,) remains unneceſſarily expoſed to all the violence of this fire.

This expoſition, which I take to be a juſt one, diſcovers my ſentiments on this ſubject; it is true we do not now practiſe theſe epaulements, but is that a reaſon we ought not?

Tho' their utility appears evident to me, I do not pretend to ſay, they muſt be raiſed on all occaſions; for example, when we intrench in haſte, in the preſence of an enemy, we muſt not do by halves what is abſolutely neceſſary, and loſe time, in what may only be uſeful by chance: beſides, will it not be the heighth of imprudence to fatigue the men too much, who muſt engage a few hours after? ſo far from that, I would have theſe epaulements made only in thoſe lines, conſtructed at leiſure, which may be of uſe ſo long as the war laſts.

There is alſo ſome eſſential circumſtances to be obſerved in placing theſe works. "We raiſe them, ſays *Vauban*, principally in

 "the

"the parts commanded from without, sel-
"dom in any others." It is certain, that they are most wanted there, but they will yet be very useful in level ground, especially if the intrenchment be weak; but if the parapet of the line, by its profil or position, will cover the cavalry, or if the ground on which they are drawn up is so low, that they cannot be seen over the parapet, then such a precaution might be ridiculed, as the line itself serves instead of it, tho' always less perfect, because the troops, at a distance from the parapet, are most exposed to the enemy's shot.

These epaulements, generally made in the most open places, have one more advantage (supposing cavalry in proportion) which is that of covering the front, and sometimes the rear of the camp.

I never saw them but at the lines of the *Loutre*, between *Wissembourg* and *Alstatt*, but they were half in ruins: M. *Vauban* placed them at an equal distance from the line and the head of the camp, parallel to them: he made them about 40 fathoms long, 9 or 10 feet thick, and as high; and 50 or 60 fathoms interval between each.

V. It is common with the more northern nations, to place platoons of infantry between the squadrons: this precaution, which was so well known to comte *de Montecuculli*, and so much recommended by the commentator of *Polybius*, has often succeeded with the

the *Swedes* againſt the *Germans*, and with the *Germans* againſt the *Turks*. Such a fire, always very briſk, and better directed than that of carabines, is in effect very proper to protect the motions of the cavalry; may it not then be here as advantageous, at leaſt in certain caſes?

The cavalry of the line being repulſed and half broke, I would have them rally behind theſe epaulements; and to give them time and means to do it, there ſhould be a ſudden and ſmart fire, that they may not be followed too cloſe.

A ſcheme I propoſed in 1735, for raiſing a battery at *Philipsburg* to defend our forage, appears to me perfectly convenient here. P.XXXII. We may form the common epaulement, only Fig. 2. obſerving to make a banquet in its ditch, and to raiſe its counterſcarp like a flat parapet, about two feet high, that the fire may be the better directed.

It is obvious this will not occaſion any increaſe of labour; and I believe that an epaulement thus lined, with 50 or 100 ſoldiers, firing nearly level with the ground, would be very terrible, and prove a great ſupport to a diſordered troop. This conſtruction has yet this advantage, that if circumſtances do not permit it to be uſed, there is no inconvenience follows.

In places level, but of ſmall extent in proportion to the number of infantry to be diſpoſed of, a Banquet may alſo be made behind the

P. XXXII Fig. 3. the epaulement, and the usual slope given to the parapet: two lines of fire thus disposed, must probably have a great effect, as the depth of the ditch, and the slope of the upper banquet equally protects the soldiers above and below from the approach of the enemy's cavalry.

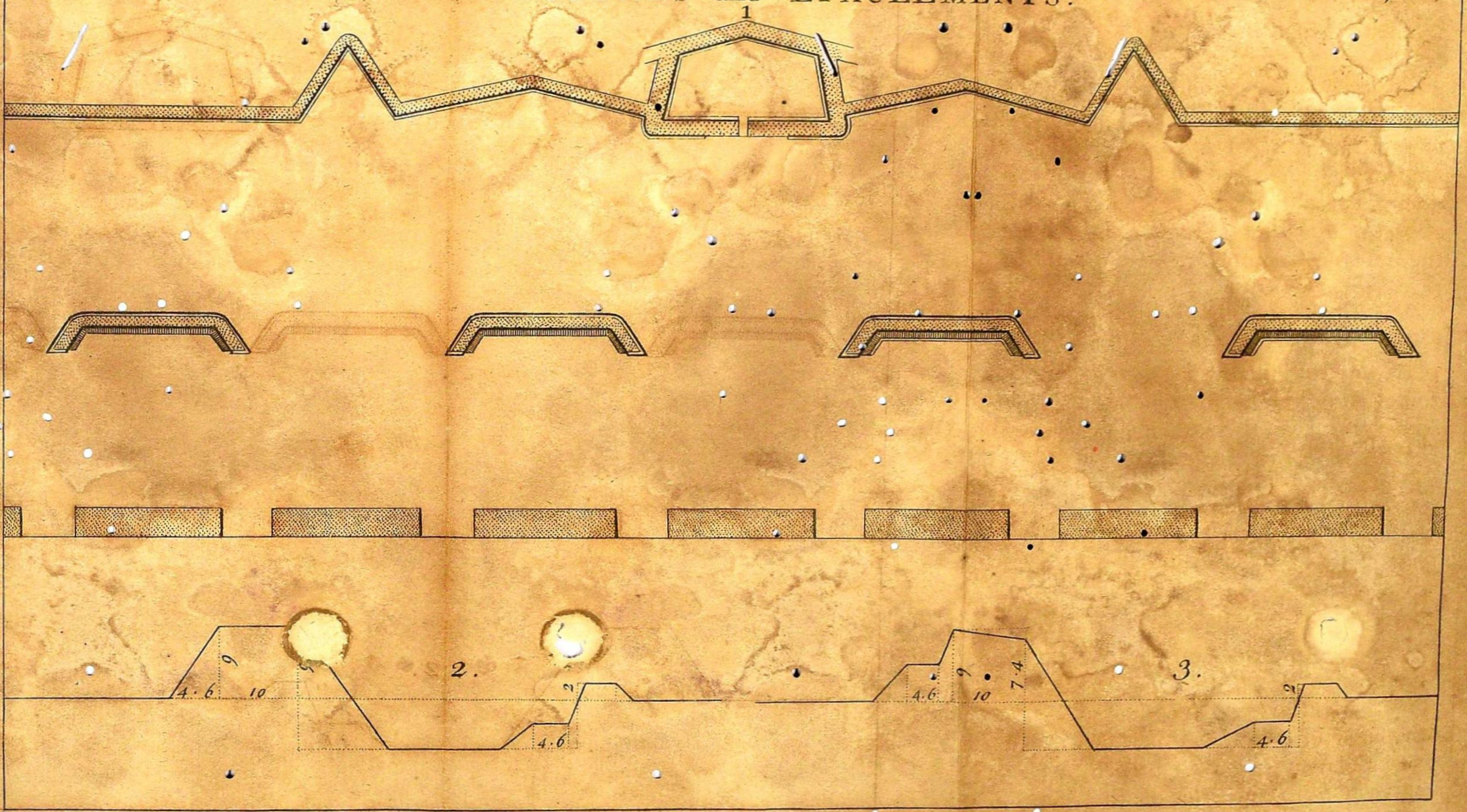
The crotchets, as in the plan, also seem good to cover them from oblique fires; they form little flanks from one epaulement to another, and even cover each other if the enemy come on the flanks; and in this case also, the two ends of the ditch, formed like the rest of the parapet, will greatly strengthen this defence.

VI. I shall only mention the inconveniencies of bog-houses; wherever they are placed in the lines, they are always troublesome; if without, they facilitate desertion; if within, they are a nuisance, and sometimes break the line of battle.

VII. If we do not take care to cover the gates, it is plain, that the enemy's cannon will break the barriers, and firing through, will batter one part of the camp, in proportion to its situation and the breadth of the openings.

XXXIII. Fig. 1. The custom in common lines is to cover them with detached redans in form of ravelins. M. *Vauban* makes the capital 22 fathoms, and the faces 28: the gorge is thus 34 fathoms, 3 feet, 10 inches; which, not agreeing with the sides of the figure in the book,

INCLOSURES and EPAULEMENTS.



book, proves there is ſome miſtake in the numbers

He forms the flanks by taking 10 fathoms from the face, and 5 from the gorge, but making thus an angle of 98°, 35,′ 30,″ only with the counterſcarp, all the fire is directed towards the next redan, which gives room to ſuppoſe, that the principal deſign of theſe flanks, uſeleſs in themſelves, is (by ſhortening the faces) to give more effect to the fire of the curtain, of which they yet maſk near 25 fathoms.

The ditch of theſe works, parallel to the faces, muſt be produced to that of the line, that it may be commanded throughout: by this we are obliged to raiſe and remove a great quantity of ſuperfluous earth, and which muſt be eſteemed an inconvenience, but much leſs than the other.

Beſides, theſe ravelins produce a very good effect: the fire of their faces, croſſes near the capital of the redans, which, as we have obſerved, have great need of this aſſiſtance; and it perfectly covers the gate and the bridge. An advantage very deſirable in the ravelins of places, which often are abandoned for want of a ſure communication.

I ſee nothing more to be obſerved on this head, except, that ſuppoſing the counterſcarp 3 fathoms from the parapet, as one of the lines of fire of the redan will paſs at leaſt ſix fathoms from the point of the ravelin, we cannot diminiſh the front of the line more

than 15 or 16 fathoms; for if, for example, it was reduced to 100 fathoms, this point would be battered.

XXXIII. Fig. 2. VIII. A few words added to the inſpection of the plans, will ſhew my method of covering the gates of the different kinds of lines propoſed. For thoſe with redans, where the barriers cannot be better placed than in the ſaliant of the curtain, maſk them with a lunette of 16 fathoms capital, reckoning from angle to angle: make the faces 20 fathoms long, drawing them to the rentrant of the redans, and the fire, ſuppoſed perpendicular, will graze without battering them; I here mean the ſecond ſcheme of 150 fathoms front, which on that account is preferable to the other. The extremities of the ditch of this little work, if not full of water, muſt be ſloped in a glacis reverſed, that the enemy may not find any ſhelter.

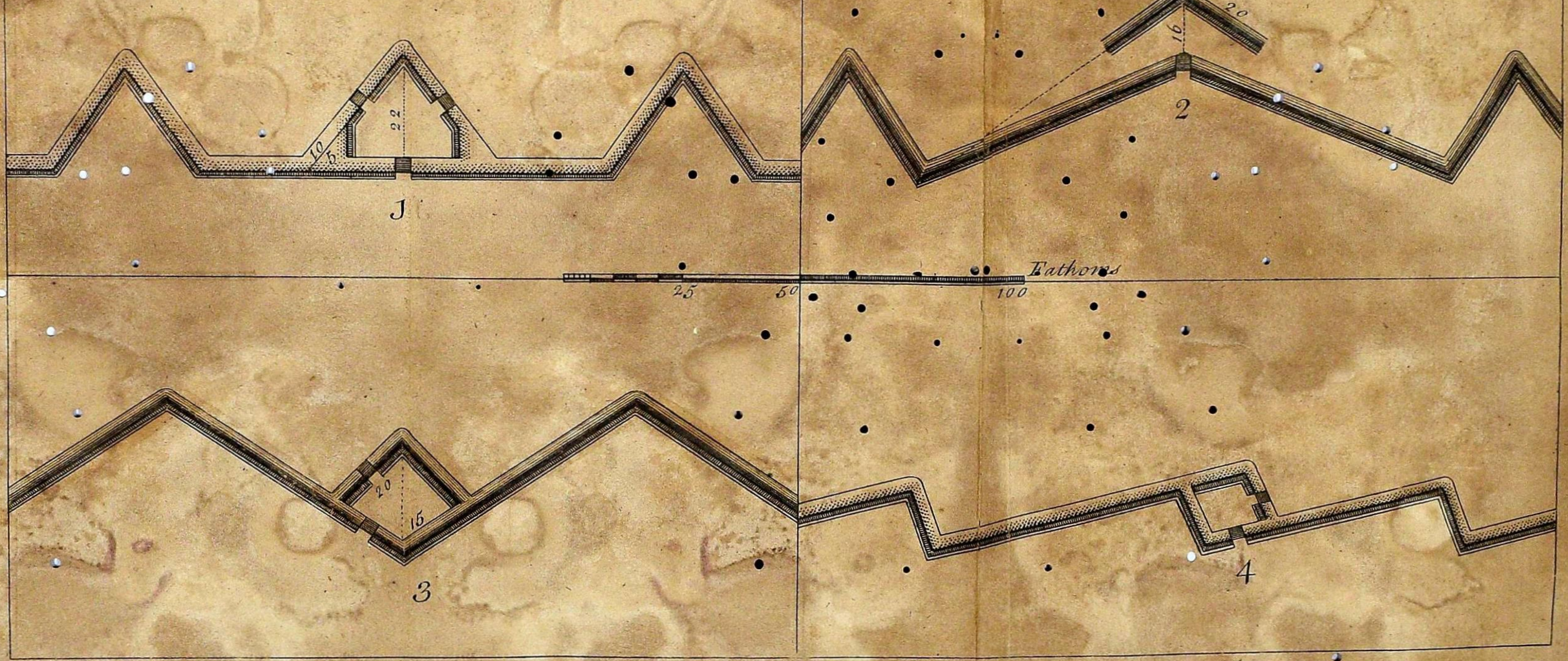
XXXIII. Fig. 3. A lunette of 20 fathoms capital, and 15 fathoms demi-gorge, placed at the rentrant of lines, with tenailles, will cover their barrier.

XXXIII. Fig. 4. That of indented lines, are maſked by a reduit, formed on one ſide by the prolongation of the branch, and the other parallel to the crotchet.

Pl. XX. Fig. 3, 4. The excavation of the branches of the communication, viz. the part of the branches between the traverſe and the ditch, ſerve for covering the barrier of the two kinds of lines with lunettes, and thus ſave ſo much work.

The

GATES and LINES



The baſtion lines in this reſpect are much more difficult than the reſt, and unfortunately I cannot quote thoſe of *Philipſburg*, for their barriers were not covered. The difficulty ariſes, by ſuppoſing, as I have done throughout, the ſmall arms to fire at right angles; ravelins cannot well be uſed, for if they are only ſeparated from the faces of the baſtion, by the breadth of the ditch, they maſk almoſt all the fire of the flanks, as already obſerved; and if they are as far from the faces, as ſhould be, that is, the length of the flanks, we not only run the riſk of having theſe pieces flanked, and taken in rear, by the gorge, but the communication would not be ſo ſecure, and the barrier wou'd even be ſeen obliquely from the extremities of the ſhoulder.

I have given here two ways of avoiding theſe inconveniencies, the reader may decide which ſeems to merit the preference.

The firſt is, to make a *Fauſsbraye* before the curtain: it is 12 fathoms broad from the parapet that carriages may paſs eaſily, and that they may be flanked by the baſtion. The ſecond is a little more compounded; draw a line from the ſhoulder of one baſtion to that of the next; divide this line into two, and from the middle let fall a perpendicular inwards, equal to half this line, its extremity will be the point of the angle of a redan reverſed, whoſe branches are drawn from that point to the ſhoulders of the baſtion. The

XXXIV. Fig. 1.

XXXIV. Fig. 2.

curtain

curtain being thus broken a ſecond time, raiſe a parapet on the firſt tracing, and it will ſhew the figure.

This rentrant angle being a right one, and its branches grazing the ſhoulders, their fire, tho' leſs advanced than they were, paſs beyond the capitals of the baſtions, and cut them, which muſt be an advantage. Detached baſtions are very neceſſary to cover gates, and the lines with detached works, or thoſe detached in parts, having no occaſion for theſe additional works, I have nothing more to add to this article.

IX. In my maxims, I ſaid we might, without danger, even in dry ground, cover every flanked work with an advanced ditch, provided the flanks were not too oblique, and ſufficiently ſaliant; I will here explain myſelf.

An advanced ditch will be always uſeful, and ceaſe to be dangerous, when ſeen and battered throughout its extent; the enemy will then not find that ſhelter, that cover, and that ſecurity, which have made the greateſt maſters reject them; in ſhort, the enemy will be as much expoſed there, as on the counterſcarp,

To effect this, 1*ſt*, the advanced ditch muſt be enfiladed at right angles, or at leaſt under an angle from 90 to 100 degrees, with the flanks of the line: 2*dly*, conſequently its diſtance from the ditch muſt be ſuch, that its counterſcarp does not project beyond the interior

terior angle of the ſhoulder, that the whole ditch may be under the fire of ſome part of the flank: *3dly*, that at the rentrants the advanced ditch be produced, and cut down in form of a glacis reverſed, ſo as to leave no cover, as I have already ſhewn.

Theſe circumſtances, which remove all difficulties, are eaſily to be obſerved, in the moſt part of the works I have propoſed. I will give two examples. In lines with redans, trace the advanced ditch parallel to the ditch, becauſe the angle of the flank with the branch is only 99°, 34,′ which is not too much; and if I had made it ſquare with the line, it would have thrown me more than 16 fathoms towards the country oppoſite to the break, and in proportion oppoſite to the point of the redan. XXXIV. Fig. 3.

In broken lines with tenailles, which I here ſuppoſe with lunettes, I do not follow the parapet, which lengthens the ditch to no purpoſe, and which would alſo be much leſs defended; but it is parallel to the principal lines of defence, and conſequently ſquares upon the flanks. If to this we add the neceſſary ſlopes, it muſt be confeſſed that this piece of fortification, far from being hurtful, becomes uſeful even in dry ground. XXXIV. Fig. 4.

Its moſt remarkable advantages are, *1ſt*, that if the ſlope be the leaſt ſteep, the firſt rank of the aſſailants, embarraſſed with their faſcines, throw them in here to leap over, ſo that they have them not to fill up the ditch of

of the intrenchment. 2*dly*, that far from ſerving the enemy as a place of arms, to take breadth in, and there oppoſe the line with ſmall arms, as they will find no cover there, they will quickly leap out of it, and conſequently in diſorder.

Theſe obſtacles become almoſt inſurmountable, if we have time to dig pits between the ditches: nothing is fitter to diſconcert an enemy in an attac, or more difficult to fill up. 'Tis with this view, viz that the enemy may not know where to tread, that in the firſt figure, and at the ſaliant of the ſecond, I have only left about four fathoms diſtance, from one ditch to another, that three rows of theſe pits placed alternately may be ſufficient.

The earth of theſe wells is thrown up in little heaps in their intervals; that of the advanced ditch, whoſe contents is leſs conſiderable, may be thrown in form of a glacis on its counterſcarp.

X. We may draw new advantages from advanced ditches, when judged neceſſary: *viz.* That of conſtructing ravelins before the curtains of baſtion'd fronts, without falling into the inconveniences mentioned in the 8th article of this chapter.

It is evident, that thus we are free from the danger of being taken by the gorge, without being obliged to maſk part of the fire of the flanks: this is an eſſential point, yet as there muſt be a gate in the line, to communicate

municate with this detached work, and we must as much as possible hide this gate from the enemy, there must be some other measures taken.

We shall fulfil this point only in proportion as we diminish the distance of the ditches: therefore we must particularly observe. That the fire of the flank only beginning from the interior angle of the shoulder, we may without danger from thence draw the demi-gorge of the ravelins, which will thus lessen its distance from the parapet: we do not in fact gain much by this, but we should much more, if we placed two pieces of cannon in that part of the flank next the shoulder, which if charged with grape, and pointed between the two ditches, at the time of the assault, must do great execution. Besides, as the distances is small, these pieces may be moved from the flanks to the faces, having but one to remove entirely.

We may then without inconvenience draw the demi-gorge of the ravelin, and the counterscarp of the advanced ditch, 5 fathoms from the angle of the shoulder, taken externally, so that drawing the faces of the ravelin on the faces, at the like distance from the angles, the barrier, and also the communication will be pretty well covered.

This ravelin is traced according to the common method, viz. taking the distance of the two points; where the faces of the ravelin fall upon the faces of the bastions, as a XXXIV. Fig. 5.

base,

base, and constructing two triangles thereon, one a rectangular, and the other an equilateral, and dividing the distance of their summits into two, that point will be the point of the saliant angle of the ravelin.

These pieces after all, tho' low and weak, cause a great increase of work, and I own, as I have done in chap 5. that I do not approve of detached works in field-fortifications, especially when we have not means and time to render them capable of resisting an assault. I therefore think we should only make ravelins to intrenchments of small extent, and made with great care; such, for example, as intrenched camps, especially when they can only be attacked in one part, as those of *Russenheim* and *Spire*.

OBSERVATIONS on the eleventh Chapter.

Little can be added to what the author says, concerning barriers and their coverings. We shall only observe, that in bastioned lines, as represented in fig. 1, 2, plate 34; the coverings contain more work than is needful; since a travers behind the curtain, of a little more length than the width of the barrier, will be sufficient to prevent the enemy's cannon from molesting the troops in the line. The ravelin in figure 5, seems too large, and might be much less, without losing the advantages the author proposes by its construction. For if the

the counterſcarp of the ſecond ditch, which terminates the gorge of the ravelin, was to meet the inner angles of the ſhoulders, as likewiſe the faces of the ravelin, both being produced, it would be ſufficient; and I would prefer the making the paſſages out of the ravelins, at the extremities of the faces, and not in the middle of them; becauſe they would in that caſe be defended by the fire, from the oppoſite flank directly, and by the oppoſite face in flank, which is all that can be done or deſired; and the fire of the flanks would then not be maſked by any part of the ravelin.

CHAP.

CHAPTER THE TWELFTH.

I. *Irregular fortifications: maxims:* II. *Rentrant angles.* III. *Saliant angles.* IV. *Manner of occupying heights, of preventing their being enfiladed, and tracing works on their descent.* V. *Reflections on heights.* VI. *Villages and buildings within reach of the work.* VII. *Case where detached works are necessary or useful.* VIII. *Woods.* IX. *Morasses, hollows, hollow roads, hedges, rivulets.* X. *Manner of proportioning to the ground the lengths of the fronts of the proposed methods.*

I. I have hitherto supposed the intrenchments raised on level ground, and the lines so uniform, that all the tenailles were equally disposed, and on the same line: in a word, I have supposed the works quite regular. I thus followed the method taken in treating of the fortification of places, and I did it with the same intent, viz. to form the subject, by establishing general methods, to follow as much as possible in the execution; for ground is seldom found so uniform, but that the regularity is at least as difficult to be observed in one case, as in the other.

We should then much less regard what has been said on this subject as positive precepts, than as general notions, proper to multiply and rectify the particular ideas, which circumstances require in practice. The engineer

gineer muſt know how to act, according to the circumſtances, and it is a great advantage to him to have many different methods to compare, and to follow that which ſeems the beſt.

But we ſhall preſently find how much we muſt expect from theory; for the irregularities of the ground and other circumſtances, vary ſo much, that all that can be added to what has been already treated of, is to ſhew how to take certain advantages, and to avoid, and to ſurmount ſome foreſeen difficulties, generally very common.

I ſhall give but few maxims on this ſubject; but they are as important as extenſive: One, that all parts be as much as poſſible, ſo equally capable of reſiſtance, that one part need not be feared more than another; its plain in this reſpect we muſt regard the advantages of the ground: the other, to have as much attention, to gain by every thing that may be favourable, as to avoid what may be hurtful.

II. A turning, a winding, a projection in the lines may be regarded as an irregularity, but that is almoſt always unavoidable. If the angle it forms be a rentrant, it ſometimes encreaſes the defence; if a ſaliant, the con- P. XXXV.
trary. Rentring angles, right or obtuſe, and Fig. 1, 2,
thoſe which are acute are often fortified after 3, 4.
different methods. A rentring from 90 to 120 degrees, though the defence be very oblique, forms a tenaille, and conſequently flanks

itſelf, provided its branches, being of a proper length, are ſhortened by degrees, as it is more open; ſo that at 90 degrees they have but 80 fathoms; at 100 degrees 70 fathoms; and 110 degrees 60 fathoms, and at 120 degrees they have but 50 fathoms.

This ſhortening is neceſſary, that one part of the fires may croſs the capitals, which could not be without that; for they fly off from the ſaliants, in proportion as the angle is obtuſe. I do not give this as a geometrical rule, it will only ſerve in practice, and ſufficient in common caſes. I ſay in common caſes, for if the ground on the right and left is not on the ſame line, we muſt have regard to the difference the inclination of P.XXXV. Fig. 5. theſe new angles gives to the capital. The figure will explain what I mean, and ſhew that the ſaliant on one ſide, tho' double in length to the other, can be better defended.

P.XXXV. Fig. 6. When the branches are too long, or the angle very open, ſome indented work will remedy all at once, as it not only forms new flanks, but alſo diminiſh the opening.

As to rentrants under 90 degrees, they are fortified according to the breadth of their opening: if it is only 120 fathoms, it will do well enough, as an enemy would be thereby engaged between two fires. A ſimple parapet in a right line, always neceſſary to cover the communication, and to prevent the camp from being battered obliquely, ſeems ſufficient; yet as the enemy may throw themſelves

all

all on one ſide, or attac both at once, it is beſt, that the anterior parts be flanked, and the branches ſo diſpoſed, at leaſt for a certain depth, that they may be uſed without firing on each other.

On this occaſion I ſhall once more venture my thoughts, in giving a ſcheme for an opening of about 200 fathoms: I know that in the treatiſe of the attac of places we find one of theſe rentrants fortified to the very bottom by indented works; but if we reflect that branches with more than 200 fathoms interval, exceed the range of a muſket, it muſt be allowed as this is a different caſe, I cannot follow this example without breaking through the rules. P. XXXV. Fig. 7.

III. *Vauban*, as well in this, as in his inſtruction on the ſiege of *Aeth*, gives ſome ſaliant angles, all fortified; the moſt open by baſtions, the others of 90 degrees at leaſt by demi-baſtions, and by the intrenched camp at *Dunkirk* it appears, that when they were acute he cut them to make tenailles.

We are ſeldom obliged to make theſe laſt angles; yet as we may have occaſion to poſſeſs a point of land, I will ſhew in a general manner how I would flank all from 60 degrees to the greateſt opening.

The angle of 60 degrees, being the moſt acute that can be admitted in fortification, muſt not be diminiſhed: its flanks muſt conſequently be taken externally; the beſt for this purpoſe, as being the leaſt ſaliant, are P. XXXV Fig. 8.

indented crotchets, which may ſerve for all others.

P.XXXV. Fig. 9. As the right angle has 30 degrees more, it may be defended different ways; I would prefer the preceding, taking the crotchet within, if poſſible, for it will be yet 61 deg. 56 min. If a demi-baſtion is thought beſt, care muſt be taken that the face be defended, and that no part in the front fires on another; but independant of the irregularity, it appears to me that we ſhall have gained nothing, for it is the ſaliant that muſt be defended, and two flanks near 15 fathoms each, one of which is only 60 fathoms diſtant, is better than one which is leſs than 27, and more than double that diſtance, which is that of the common redans.

P.XXXV. Fig. 10. If theſe conſiderations do not appear ſolid enough, trace that figure in this manner. Draw a parallel 22 fathoms from one of the ſides; at 120 fathoms from the angle, raiſe a redan of 22 fathoms perpendicular, and 15 fathoms demi-gorge; draw one line of defence from the angle of the figure to the rentrant of the redan, and the other from the point of the redan to the gorge of the demi-baſtion, which make 25 fathoms; elevate the flank perpendicular to this laſt line.

This angle being ſquare, might be made a baſtion; but ſo crowded, and of ſo little defence, that we ſhould reject ſuch a conſtruction here, as much as in the fortification of places,

places, where it is never uſed, when it can be avoided.

The angle of 120 degrees, being that of an exagon, may be fortified according to all the methods I have given, except in thoſe with tenailles, and broken tenailles; it wants but 30 min. of being enough for this; ſo that it may be uſed, diminiſhing the perpendicular two or three feet only, for greater exactneſs. P.XXXV. Fig. 11.

Finally, the angle of 150 deg. is open enough to execute any of the different ſchemes that may be choſen for the reſt of the lines. P.XXXV. Fig. 12.

Whatever then be the ſaliant, we can flank it according to one or more of the methods I have given for regular fortification, and it is certainly an advantage to confine theſe irregularities to fixed rules, obſerving only, that if the angle be leſs than 60 deg. or that we cannot uſe the crotchets, we muſt make it leſs ſaliant to give it the greater opening.

IV. The unequal heights of the ground, is one of the principal cauſes of the irregularities, as well in the profils, as in the plan of the works.

The ſaliants of every kind of fortification muſt be at leaſt as high as their branches, even ſuppoſing the ground perfectly level; for if the part the moſt advanced ſhould be loweſt, its parapet would cover it leſs in proportion as one would be farther from it, whereas if the ſaliant be higheſt, one cannot

be seen even from a much higher ground than that we are on.

It is therefore always useful, and often absolutely necessary to raise the flanked angles higher than the rest: the earth taken from the rounding of the ditch serves for this purpose; but as this is of little consequence, excepting in even ground, we must endeavour to place these angles on the highest places; we also thus prevent the bad effects of the ricochet, and command better in front.

When we cannot by this means prevent being seen from an eminence too near, and have not time to raise the parapet of the angle as high as needful, there are two methods left, little or not at all used in *France*. The one is to raise the parapet of the angle some feet, in form of a cavalier, for the breadth of the terreplein, that the troops which occupy the branches may be covered. This the *Germans* call bonnets, and we surtouts; there were some in the hornworks at *Philipsburg*.

If it is only some particular work we would cover, the same method is used by turning one or more angles to the enemy: these surtouts are also so proper to guard against the ricochet, that I am surprised they are not more used in our fortified places.

The other expedient signifies little against cannon, but it is readily and easily done, and entirely covers the men; it is to place, on the parapet that should be raised, a row of gabions

gabions larger at top than at bottom, that they may form a kind of loop-holes; M. *de Caligni*, director of fortifications, from whom I had this idea, aſſured me he had uſed it with ſucceſs. Theſe gabions reſemble much thoſe hampers or baſkets on the rampart, which, according to the chevalier *de Ville*, and ſome other authors, were formerly uſed inſtead of our ſand-bags, if their chief uſe was not to prevent being plunged; a more eſſential one than that for which baſkets was invented. In ſhort, if theſe means will not do, we muſt, according to *Vauban*, poſſeſs the commanding ground, either by extending the lines to it, or by good redouts, or ſome other works.

When the line of the front cuts one of theſe eminences, and that we muſt conſequently mount it, and deſcend it, was it even parallel to the enemy, we are obliged to break it, in ſuch manner that the ſaliant be at top, and the rentrant at bottom. The reaſon of this, little different from what we have already alledged, is, that if the line was continued ſtrait on, we ſhould in reality be covered in front, but not being ſo on the ſide where the ground falls, the parapet of that part would not hinder our being ſeen obliquely.

It is ſeldom we project beyond the line, in deſcending a hill, yet it may happen, as in the communication of ſome detached work; the only method I know to avoid be-

being plunged, is to trace the communication in zig-zags, like the branches of a trench; the more acute the angles are, the leſs they are ſubject to be enfiladed, and the ſhorter the branches are, the more they are covered by the crotchets.

V. I will add ſome reflections on ſo important a ſubject. We ſhould, if poſſible, poſſeſs the heights, was it only to prevent the enemy from moleſting us from them; yet they are not abſolutely ſo advantageous in themſelves, as is commonly imagined.

All theſe, in proportion to their height, diſcover at a diſtance, and command the depth of the battalions and columns of the aſſailants. All have beſides the advantage of being ſecured from the ricochet, and even of diminiſhing the effect of cannon, which, firing from a low place to a higher, with much difficulty enters the parapet, which it batters obliquely in reſpect to its thickneſs.

We ſhould alſo add, that the firſt rank of the enemy being higher than the ſecond in aſcending, it is conſequently the only one that can fire on the intrenchment. Theſe advantages are real, but the inconveniences attending them are more ſo.

It is eſſential here to diſtinguiſh two different ſorts of fire; the raſant or grazing, in this reſpect, is that which going in a direction parallel to the horizon, beats down all it meets with within its range, and the fichant or plunging, that which fires from a higher

higher on a lower place, and only damages whatever it meets with near the point where it falls.

This diſtinction being underſtood, explains one part of what I would ſay. Whatever be the height, every ſhot that falls, and does not riſe again, will be fichant or plunging, and conſequently leſs dangerous, even ſuppoſing the ſoldier to take aim; and as it is almoſt impoſſible, let the elevation be ever ſo little to raiſe himſelf enough, it is evident that cannon will have little effect, and ſmall arms ſtill leſs, and this inconveniency increaſes in proportion as the enemy approaches.

This concerns the plain, that is to ſay, what is beyond the foot of the hill; as to ramps or ſlopes I ſhall here ſuppoſe them of two different ſorts.

When they are ſo ſteep that the enemy cannot eaſily aſcend, and we can leap from the intrenchment, doubtleſs we ſhall repulſe an enemy out of breadth, and propably in diſorder, with much eaſe; eſpecially if, by imprudence, or too much heat, they are led on too faſt; but here alſo we cannot fire on the ſlope without being greatly expoſed, or even without mounting on the parapet.

If the ſlope be gentle or eaſy, we are leſs expoſed, but the enemy will march with as good order, and almoſt with as much eaſe, as on a level, ſo that we do not gain much by it; for I am not of M. *de Folard*'s opinion, that infantry charging from a higher

on

on a lower place, come with greater weight, and the cavalry the contrary.

I believe we may conclude, that the most advantageous heights, in all respects are those which are steep and difficult of access, provided they are so situated, that flanks may be made to batter what we cannot see in front; or else those eminences with a gentle and easy slope, when this natural glacis is near the length of a musket range.

We cannot be too attentive in placing these works, so that they possess the summit of the hill; at least we must take care, that by the irregularity of the ground some part of the camp, or the troops when darwn up, be not seen from without.

VI. When a village is found within reach of the shot, it must either be left in rear, or fortified so as to serve as a flank to the rest.

This is of great importance, for if you abandon it to the enemy, it serves them as a support, it hides their dispositions and motions, and enables them to discover yours.

When the village is so near as to be hurtful, and in a low ground, or too much embarrassed with hedges, *&c.* to run the line there, there is not much more to be done than making it a detached post: so long as this post shall subsist, it will be a security to that part that cannot be attacked, but by exposing their flank to the fire of the village: but as it is liable to be attacked, because it is detached, it will be prudent, let the distance

tance be ever ſo little, to ſecure a communication, ſo as to prevent its being eaſily ſurrounded.

Some redouts are ſufficient for this; every difficulty would then be overcome, if there did not often remain inconveniences much more conſiderable: we have ſeen in chap 4. that there are many villages that cannot be fortified; beſides, ſuch a place requires much work, and to guard it requires more troops than we are ſometimes able to detach from an army.

In theſe circumſtances, the common expedient, and which appears the beſt, is to burn the village; but I venture to affirm from what I have often ſeen, and lately at the ſieges in *Flanders*, that unleſs the houſes are all of wood, as in *Bohemia* and the *upper Palatinate*, we gain little or nothing by it. What advantage do we reap by ſetting fire to a houſe built with earth or maſonry? the roof, floors and doors conſume, but the walls remain, and they are ſufficient to cover the enemy. Beſides, we ſhall find that it is not the houſes, ſo much as trees, hedges, and the walls of encloſures, which affords this cover, and the fire does not deſtroy them.

We ſhould not then have recourſe to this means, but when we have time to cut down and level with the ground all that may be hurtful; as it is rare that we do this, but when it cannot be avoided, that is to ſay, at the

the laſt puſh, it is alſo very ſeldom we reap any advantage by theſe cruel actions.

The ſureſt way is to avoid ſuch a troubleſome neighbourhood as much as poſſible. As to leſs conſiderable encloſed places, ſuch as houſes or caſtles, we ſhould not heſitate to poſſeſs them, as little uſeful as they may be, for fear they might be hurtful, as they are ſupported with little work and few troops. We have ſhewn how to defend them in chap. 3.

VII. Theſe laſt works are ſo neceſſary, that when not found ready made, we are obliged to conſtruct others inſtead of them. One of the moſt eſſential maxims in every kind of fortification is, not to leave the enemy any cover, within a certain extent, which extent ſhould never be leſs than that of muſket range. If the line or intrenchment is at a diſtance from a valley, too low to be ſeen, or any other circumſtances produces the like effect, there muſt of courſe be ſome work added.

The ſame ſhould be done to ſecure communications to heights, when we fear they may be hurtful; in fine, if we have a dam, a bridge, a ford, or any other defile before us, it muſt be defended near and by a grazing fire. Beſides theſe detached works, others are ſometimes made, which are only ſeparated from the line by the ditch: theſe are made to ſtrengthen a place greatly expoſed, to poſſeſs a point of land, or to flank the adjacent parts.

I

I ſhall not give the various methods of tracing theſe works, as their figure depends on circumſtances; and as I have given ſo many different ſchemes already, no one can be at a loſs in this reſpect; I ſhall only add, that the moſt material thing is to ſecure the communications, and to turn the branches, ſo that they do not fire on the lines; the adjacent parts alſo muſt be ſo turned as not to fire on the branches.

VIII. Woods as well as heights have their advantages and defects; if full of thickets, and difficult to paſs through, and not above 100 or 150 fathoms diſtant, they are advantageous to the defence of the intrenchment, as the enemy cannot make their way through, without being heard by the patroles, and advanced guards, which gives us an opportunity of drawing our troops to the places attacked; beſides, they run the riſk of being charged before they can get clear, and are drawn up: in this caſe the barriers ſhould be large, and at a little diſtance from each other, ſo as to ſally out with a conſiderable front, and at many places at once.

But if the wood be clear, high, and without brambles and briars, as moſt fir woods are, and are cut through by broad and good roads, as that of *Philipſburg*, the enemy will be able to conceal their diſpoſitions and marches, to attac us when we leaſt think of it, and to retreat when they pleaſe, without fear of being purſued, at leaſt very ſpeedily, provided

ded they have taken the precaution to line the borders with infantry, to favour their retreat.

If the wood is nearer, the enemy have greater advantages, and if at a greater diſtance, as 400 or 500 fathoms, they cannot indeed fall on the line, ſo very unexpectedly, but their retreat will not be leſs ſecure. In ſhort, when we are maſters to chuſe the nature and ſituation of the ground, it is the buſineſs of the general, rather than of the engineer, to weigh well theſe conſiderations.

When the line muſt paſs through a wood, and by nature it is not capable of ſupplying the place of one, for reaſons given in chap. 2. cut it down to the ground, from the foot of the intrenchment to the rear of the camp, and pile up the fellings at 150 fathoms in front at leaſt.

IX. A moraſs, a hollow, a hollow way, a quick-hedge, even the ſmalleſt brooks, become objects to be regarded, either to draw ſome advantages from them, or to prevent their being hurtful.

A moraſs of any kind is always an advantage, if it extends to the foot of the line, ſince it renders it inacceſſible to cavalry at leaſt: if it be of any breadth, and its bottom boggy, it ſerves as an intrenchment; if it appears needful to line it with a parapet, it need only be an epaulement againſt cannon, conſequently need not be flanked; but we cannot reconnoitre and ſound theſe moraſſes too well,

well, that we may know how far we may depend on them; there are thousands of examples, and I have seen droves of oxen crossing those with little trouble, which were thought in the army, to be impracticable, and which perhaps were so some months before.

Hollows, hollow roads, and in general, every thing that may serve as a cover, must either be enfiladed or flanked by the line itself, or as in chap. 7. by some detached work, so as to discover the bottom. These cavities not only cease to be hurtful, but also become useful, as they are so many additional obstacles to the enemy: if we find a quick-hedge, and the intrenchment can be so turned, as to preserve it on its berm, it will serve instead of pallisades.

If there is a brook too small for an inundation, it must be damm'd up here and there to fill it full to its banks, and form little pools: or, if it runs into the intrenchment, we must try to fill the ditch with it; I shall not here speak of considerable brooks, nor rivers, having already largely treated of them in chap. 9.

X. The different projections of the line, being always determined by some one of these circumstances, it is evident we cannot always make the fronts of an equal length, as we are often obliged to add or diminish a certain extent.

The numbers and variety of methods I have given, will be of great assistance in this respect,

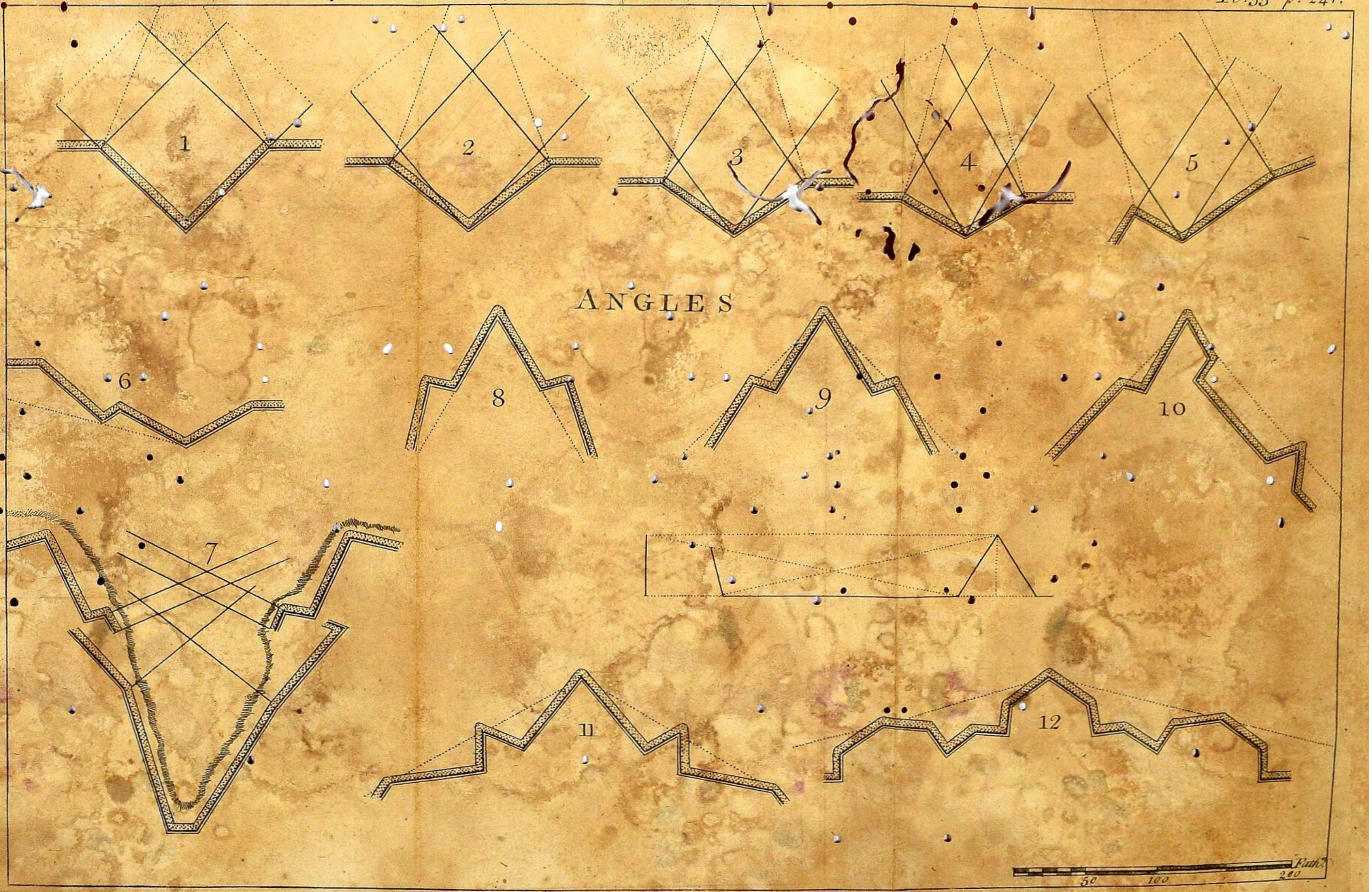
respect, as they are for fronts of 60, 100, 120 and 150 fathoms, besides these fronts may be diminished, provided it is done with judgment.

If we would have lines with redans, 30 and even 50 fathoms shorter, we may follow the common methods, without any alteration, excepting the break of the curtain, as in chap. 6. The fronts of lines with tenailles may, without inconvenience be reduced to 50 fathoms, by shortening the perpendicular, so that it does not exceed the half of the front.

The indented branches, fixed at 60 fathoms, may be reduced to less than 30, but the flank must in this case be at least 12 fathoms, and perpendicular, and its branch must also be protected by an adjacent fire, such at that of an higher crotchet. Finally, the fronts of other lines closed may be shortened a fourth, observing to follow the proportions of the given dimensions; the figures being similar, the directions of the fires will always be the same.

If, to the combination of these different measures, we add what has been said on each particular front, nothing need be desired more; but it must be observed, that it is much better to shorten than to lengthen them in this case, because the fronts generally become stronger by the first, and consequently weaker by the last.

OBSER-


ANGLES
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OBSERVATIONS on the twelfth chapter.

I ſhall only add a few remarks, to what is ſaid in the fifth article concerning retrenchments upon a hill or riſing ground. The author does not ſeem to think, that a ſudden riſe is ſo advantagious as it is commonly ſuppoſed because the ſoldiers cannot fire upon the aſſailants without diſcovering themſelves too much: but in ſuch a caſe, the parapet of the intrenchment need not be ſo high than on level ground, and made with a ſteep ſlope or glacis; beſides, wherever there is a favourable ſpot of ground flanks are made: but ſuppoſe the enemy attacks, he muſt receive a grazing fire along the ſlope without being able to return it; and if the foremoſt ſhould come ſo far as the line; will not a greater body of troops oppoſe him, with all the advantage poſſible, while his front rank only is able to fire. It does not appear to me, that ſuch an attac is at all practicable provided the defenders ſtand their ground. It is true, attempts of that kind have been made, but never anſwered that I know of; on the contrary, after ſeveral extraordinary efforts have been made, the aſſailants have been obliged to retire, after having loſt the greateſt part of their beſt troops.

CHAPTER THE THIRTEENTH.

I. *Profils.* II. *Reflection and example.* III. *Defects of profils too much elevated.* IV. *Observations on the author's breaks.* V. *height of parapet.* VI. *Their thickness.* VII. *Their pent or slope.* VIII. *Their interior height.* IX. *Banquets and their slope.* X. *Ditches and advanced ditches.* XI. *Other slopes, and their berm.* XII. *Glacis and covert-way.*

I. IT is not sufficient to give a work the most convenient figure in regard to the nature and quality of the ground, to defend its access; we must also know what should be its height, and every dimension proper for each particular part, and this is what we comprehend under the name of a profil. This is an essential point, not only in the execution, that each part may produce all its intended effect, but often in projecting a figure; for if we only follow a plan we may be led into an error. For example, the breaks I have proposed in many places, to distribute the fire equally, and give it a better direction, effectually procure that advantage, and in the plan, appear out of the critick's reach, yet we shall find in article 4. that they are not without inconveniences in the elevation. This important part, on which we seldom sufficiently reflect, being relative to the

the whole, ſhall be the ſubject of this chapter, and the concluſion of this treatiſe.

II. I will begin by obſerving in general that an intrenchment too weak, tho' well diſpoſed in every other reſpect, ſhould rather ſhew us the neceſſity of a remedy, and the danger, than encourage us with falſe notions. On theſe occaſions the ſoldier always meaſures by his eye the greatneſs of the obſtacles the enemy muſt ſurmount to come at him; and if they do not appear ſufficient, his ſteadineſs diminiſhes, or he is diſcouraged: it is ſeldom that we defend ourſelves as well as we might, when not ſupported with the hopes of conquering or driving back our adverſary.

An engineer therefore muſt not fear making large profils, when circumſtances require it, and he has the means to execute it. M. *Vauban*, complaining of the negligence of the *French*, in his memoirs of ſieges, would have us make two or three banquets to the lines of circumvallation, and oftener three than two, ſo that the parapet be raiſed enough to be fraiſed, and to cover the cavalry; and either in regard to the ſhortneſs of ſieges, or rather for the reaſon we ſhall explain, he reduced them to one banquet only in his treatiſe of the attac of places; we muſt obſerve that it was by no means to ſave work, ſince in profils which he propoſes againſt ſuccours, that is to ſay, in caſes where we are afraid of being attacked and forced, he

makes the ditches from 16 to 20 feet broad, and 8 or 9 deep.

What that great engineer tells us on this head, is too decifive to paſs by unnoticed here. He ſays, that *Maurice* and *Frederick Henry*, princes of *Orange*, applied themſelves ſo ſtrongly to their lines, that they employed whole months in their conſtruction, and that they made them ſo ſtrong, that tho' they were often attacked, they were never forced; that they alſo added particular forts at certain diſtances from each other, and according to the practice of thoſe times they fortified their quarters ſeparately, and advanced works on the moſt expoſed places to ſtop the enemy, and thus give time to the troops to arrive from the neigbouring quarters to the aſſiſtance of the menaced part: precautions which have always baffled the enemy's deſigns, and often endangered their being beat in their retreat. The examples of ſuch able generals, related by ſuch an author, will doubtleſs be of more weight than what can be farther alledged.

III. Having thus ſhewn the importance of giving a good profil to field-fortification, we will inquire what dimenſions are moſt proper for them. An height of 9 or 10 feet, as *Vauban* demands, requiring three banquets, that the parapet may cover the cavalry, has without doubt its advantages, ſince ſuch lines may be fraiſed, and ſerve inſtead of epaulements, and are more difficult for the enemy

to

to mount: yet this general has ſince fixed the height of the crown of the parapet, of his greateſt profils, at 7 feet and a half, even where the excavation of the ditch would have allowed an addition, without an augmentation of work: he did not apparently make this alteration without good reaſons, I will therefore endeavour to find them out. We cannot but improve by ſtudying the motives of ſo great a maſter.

We have ſeen the advantages of a grazing fire in chap 12; and that the more it is fichant, or inclining to a perpendicular, the leſs hurtful it is: but it is always more fichant in proportion to the greater height, at leaſt, as we obſerved, when the ground we defend is not parallel to the lines of fire.

Every elevation beyond * 4 feet 4 inches, which is the height at which a ſoldier of a middle ſtandard holds his piece to fire right before him, or parallel to the horizon, is therefore always a defect, which muſt be diminiſhed as much as poſſible,

Suppoſing on the contrary it is 9 or 10 feet high, and one foot in a fathom ſlope or plunge, the ſmall arms, by following this direction, cannot reach the ground nearer than 9 or 10 fathoms from the ſpot they fire, from whence ariſes a much greater defect,

* The reader muſt here obſerve that one foot *Paris* makes one foot and half an inch or 6 lines, *Engliſh* meaſure; this difference, though inconſiderable in the plans, is of great conſequence in the profil.

viz. that the enemy will find himſelf covered from the direct fire, in proportion as he approaches the counterſcarp, near which he will be out of all danger.

We may indeed remedy this defect, as we ſhall ſhew, but the firſt always ſubſiſts, and increaſes in proportion to the depth of the ditch, which forms new inconveniences.

As the bottom of the ditch is not ſeen direct, it is an unavoidable evil, and ſo evident that it is needleſs to quote it, but this muſt be endeavoured to be remedied by the flanks. It is not with field fortification in this reſpect, as with places; the ditches of the latter, if well conſtructed, are ſeen in all parts; whereas in field fortification, the ditch is much narrower and parallel to the parapet, and in certain places cannot be ſeen from any part.

Theſe defective parts, in common lines, are along the faces of the redans beginning at the rentrant of the counterſcarp: the ditch cannot be ſeen there but from the extremity of the curtain; and it is plain that the extent, which cannot be diſcovered from thence, not only increaſes by its depth, but alſo by the greater elevation of the parapet. Theſe are, if I don't miſtake, the motives that induced *Vauban* to lower his profils; I ſhould have been inexcuſable if I had departed from the maxims of ſo great a man.

IV. This is the place to reſume my ſubject, on the propoſed intrenchment. One of the

redans

redans, always diſcovering the foot of the next, according to the common method, there are not any of thoſe dead, or defective parts along the curtain, which the breaks neceſſarily cauſe in all mine.

The defect is greater in proportion I own; therefore it is only neceſſary to know, if that is as eſſential as it appears, or whether it is ſo well compenſated by other advantages, as not to reject them I ſhall therefore obſerve,

1*ſt*, That we are not commonly confined to the attac of one redan only, and if for example we include three in the attac, the two curtains which join them, have no protection to expect, each being then too much engaged in its own proper defence, to aſſiſt in that of another, thus it ſeems to be indifferent.

2*dly*, That if the curtain is attacked, as the adjacent redans will infallibly be ſo too, each will fire directly before itſelf, and in this caſe neither the counterſcarp, nor the ditch will be defended by any thing; whereas by my method, all reciprocally flanking each other, we cannot particularly defend any one, without alſo defending the part we ſhould.

3*dly*, That my capitals are covered by many croſſed fires, that are not to be found in common lines: and to avoid repetitions, I muſt beg the reader to recollect what I have obſerved on this chapter, in the different parts of this treatiſe.

I ſhall not alledge that theſe dead angles

are even found in ſtars, and in demi-baſtioned forts, and in all other works of this nature. However indiſpenſable they were formerly it is not the leſs a real defect; * and we ſhould conſequently avoid it, as much as poſſible; that is to ſay, without loſing more than we gain by it.

Though this is a fact, we muſt own all inconvenience diſappears when the ditches are full of water; my ſchemes have at leaſt ſome advantage, in this caſe, and was I miſtaken, I may be permitted to ſay, that treating on a ſubject ſo important, ſo ſimple, and yet ſo neglected, their variety will always be uſeful, and that by inciting a curioſity or emulation in thoſe that will criticiſe on mine, and perhaps give birth to more happy ideas.

V. We will now paſs over thoſe preliminary reflections, to the detail of the profils,
P.XXXVI our intended ſubject. Every intrenchment of earth, is compoſed of a parapet, one or more banquets, one or two ditches, and ſometimes a berm, and a ſmall glacis.

I have ſhewn M. *Vauban*'s thoughts on the great height of profils, and the particular reaſons I had for conforming to his opinion. I will therefore, with him, fix the greateſt elevation at 7 feet and a half from the ground.

* We ſhall find, in the enſuing treatiſe, a method as plain as ingenious, to remedy ſuch defects. It was invented by M. *de [illegible]*, mentioned in chap. I. Article 4.

Yet

Yet this muſt only be in common caſes; there are circumſtances, which oblige us to raiſe it more; ſuch as the neceſſity of commanding the environs, to plunge into ſome low part, or to cover a branch, by raiſing the ſaliant.

Works cloſed at the gorge, joined to lines, muſt be excepted from this rule, unleſs when ſo ſituated, as to command the reſt, which ſhould be at leaſt by two, or three feet. If we recollect the nature of the inconveniences which oblige us to confine the profils to this height, we ſhall find, that they are not always united. I will explain myſelf better by examples.

When we elevate a front but 4 feet, or thereabouts, above the ground we would command, it is plain we batter it with a raſant fire; though the defect of the dead part increaſes: on the contrary, when it is only neceſſary to raiſe a ſaliant to a certain height, to cover a branch, provided the rentrant preſerves the determined height for the breadth of the ditch, the fire becomes more fichant towards the flanked angle, without the ditch being leſs defended.

We may in the firſt caſe reject the breaks, if thought neceſſary; that will be ſo much gained, eſpecially if we can find any means of diſtributing the fire, as well without them; in reſpect to the ſecond caſe, that is of fires too fichant, or plunging, that defect alone is the reaſon which prevents our giving the profil

profil that height we would to works without flanks, or to thoſe that have them too oblique, which conſequently do not defend their ditch.

I do not here ſpeak of the cover the enemy finds againſt a direct fire, by approaching a work too much elevated, becauſe that is eaſily remedied, as already ſaid. A parapet ſhould never have leſs than ſix feet elevation above the ground, without which it only covers in part thoſe that are behind it; thus all the difference between the higheſt and the loweſt is reduced to one foot and a half.

VI. The thickneſs of the parapet varies much more than the height. In regard to this, the deſign and nature of the work muſt be conſidered. Three feet is enough for that which is not expoſed to cannon, for example, the intrenchment of a grand guard, four feet and a half is ſufficient for works that cannot be battered but at a diſtance; the reſt have 6 or 8, and even 12 feet is allowed for intrenched camps, heads of bridges, redouts, and other pieces, intended to ſtand a long time, or that may be expoſed to a briſk fire of artillery, or a long attac.

The thickneſs is not exempt from a defect, but is of ſo little conſequence, that it is ſcarce worth mentioning, ſince it conſiſts in unavoidably ſhortening the branches.

I do not here ſpeak of the reduction of the ſides of polygons, inſcribed in other ſimilar figures, what I mean is more eſſential, at leaſt

leaſt in the raſant or grazing defence, ſince it diminiſhes the ſaliant, and conſequently the protection of the flank: we muſt conſider that what we gain by the rentrant is no defence in this reſpect, ſince it is viſible, that when the flank is perpendicular, as we ſuppoſe, that which is within the line of defence, fires on that part it ſhould graze.

The laſt is, ſtrictly ſpeaking, a great defect; we may correct it in baſtioned lines, by advancing the curtain to this interſection, and more eaſily yet in every caſe, by rounding the interior of the parapet of that part, if ſo ſcrupulous an exactneſs was not a fault in practice, where too minute an attention to trifles often creates a negligence in more eſſential things.

VII. When we conſider that the plunge or ſlope of the parapet commonly determines the direction of ſmall arms, it is obvious, in whatever manner it is traced, it is never without inconvenience; for we do not diſcover the counterſcarp at the bottom of the ditch, but in proportion as this ſlope is great, and in proportion to its increaſe, its direction varies from the raſant line.

Theſe objects being incompatible, all we can do, is to find a mean between them that ſhall be moſt proper. I think this has been ſufficiently treated of, in the treatiſe of the attac of places; we there find parapets of 6 feet thickneſs, which have one foot and half ſlope or plunge: I own this appears exceſſive

to

to me, not only becaufe the fire becomes too fichant or plunging, but alfo it weakens the crown, and by following this direction the foldier will difcover himfelf too much, and, as we fhall find in the next article, much more than he fhould do.

I would not have above 12 or 15 inches flope in a fathom, to which I will add this obfervation. The higheft profils commonly having the deepeft ditches, this additional height and depth increafe, the one the cover in front on the counterfcarp, and both, that in the bottom of the ditch.

We muft therefore give the leaft plunge to the loweft and weakeft parapets, and increafe the others in proportion to their height, which is not at all inconvenient, for befides their greater thicknefs, the top cannot be battered but horizontally, and confequently with little effect.

On this account I find the flope at one foot in a fathom for profils fix feet high, and an increafe of one inch in every half foot, giving 13 inches to thofe of 6 feet and a half, 14 to thofe of 7 feet, and 15 inches to thofe of 7 feet and a half.

Thus fuppofing the ground level, thefe different fires fall equally on the counterfcarp at 6 fathoms from the point they depart, and at a little diftance from each other in the bottom of the ditch. As to profils of an extraordinary elevation, the greateft flope, that is 15 inches, appears to me fufficient.

VIII. Four

VIII. Four feet and a half is commonly allowed to the interior part of the parapet. It is a cuſtom, ſo generally followed, that it ſeems an eſtabliſhed maxim. This rule would have been leſs followed had it been more ſtrictly examined; it is good indeed for the conſtruction of places whoſe parapets ſink in time, and have alſo much leſs plunge, or ſlope; but circumſtances varying, it is plain that it cannot be proper here.

I know by myſelf, that a man of 5 feet 6 inches, ſtanding as he ſhould do the left foot 18 inches diſtant from the upright of the crown of a parapet four inches and a half, which is the common ſlope, fires with more eaſe horizontally, than if it had a plunge of 8 inches in a fathom. As few ſoldiers are of this ſtandard, it is not ſurpriſing that ſo many ſhot are loſt in the air.

There is but one remedy for this; it is not only to diminiſh this height, but alſo to diminiſh it in proportion to the plunge, for this circumſtance is ſo eſſential, that he ſhould be near 6 feet high, to fire over a parapet 4 feet and a half high, and 18 inches plunge in a fathom, ſuch as mentioned in the preceding article.

I therefore think that a horizontal parapet, ſuch as thoſe of ſome communications, and other works no higher than 4 feet 6 inches from the ground, ſhould not be more than 4 feet 4 inches, and in regard to others, they ſhould

ſhould be lowered in a proportion of four inches in a foot plunge.

It will without doubt be objected, that the ſoldier will be much more expoſed; I acknowledge it, but of what ſervice is a ſlope we cannot uſe? beſides, a ſoldier on theſe occaſions naturally ſtoops, ſo that more than his head is never above his firelock.

Baſkets, or ſmall gabions, ſuch as I mentioned in article 4. of the preceding chapter, would be of great uſe here, ſince they remove all difficulties, at leaſt, in reſpect to the fire of ſmall arms,

IX. The exterior height of the parapet being regulated by the interior, and plunge, there is nothing to be ſaid on that head.

A man in the attitude of firing does not poſſeſs much more room than two feet; three feet is then ſufficient for a banquet, yet we commonly allow four and a half, that a ſoldier may ſtand behind, or paſs in the rear of him that fires.

This breadth is allowed from the foot of the palliſades when there are any.

I would not have the banquet more than three feet high, it is much better to make two of two feet each than one of four, becauſe a ſlope, when ſteep, is always eaſier to mount when ſo ſhort.

Three feet at moſt is ſufficient for the lower banquets, they not only ſerve as ſteps, but alſo to draw up the ſoldiers on, to relieve thoſe that line the parapet.

The

The slopes of banquets may, also be regulated by their height; when they are only one foot, the natural slope is enough, as they have only to step a little higher on one of two feet; I allow to the base one height and a half, and two heights to those that are raised 2, or 3 feet.

In narrow places, to manage the ground, we may form steps with hurdles 12 inches high, and 9 broad, which serve instead of a slope.

X. The excessive breadth of the ditch, if it is not full of water, creates a defect in durable fortification, (or that of places) which is, that batteries on the crown of the glacis, or on the terreplein of the covert-way can, without plunging much, sap the foot of the revetement or face of the wall: but there is no reason to fear that, in these kinds of fortification.

The greater the breadth, the more advantage we reap here; the enemy is more exposed on the counterscarp; the length of the dead or undefended parts, afore-mentioned, diminish; and if the ditch is to be filled up, the work becomes more tedious, and consequently the enemy are exposed much longer to a fire very terrible because of its proximity.

We need not fear making the ditch too broad, but yet it must be regulated by the time and number of workmen allowed us, and also by the quantity of earth we have occasion for.

It is not so in regard to its depth: as in flanked

flanked works it naturally increases the dead parts, I would not have it exceed 7 feet and half. As to works not flanked, where no protection is to be drawn but from the parapet, also in ditches full of water, it cannot be too deep, since it always is an addition to the difficulty of access, without any inconvenience.

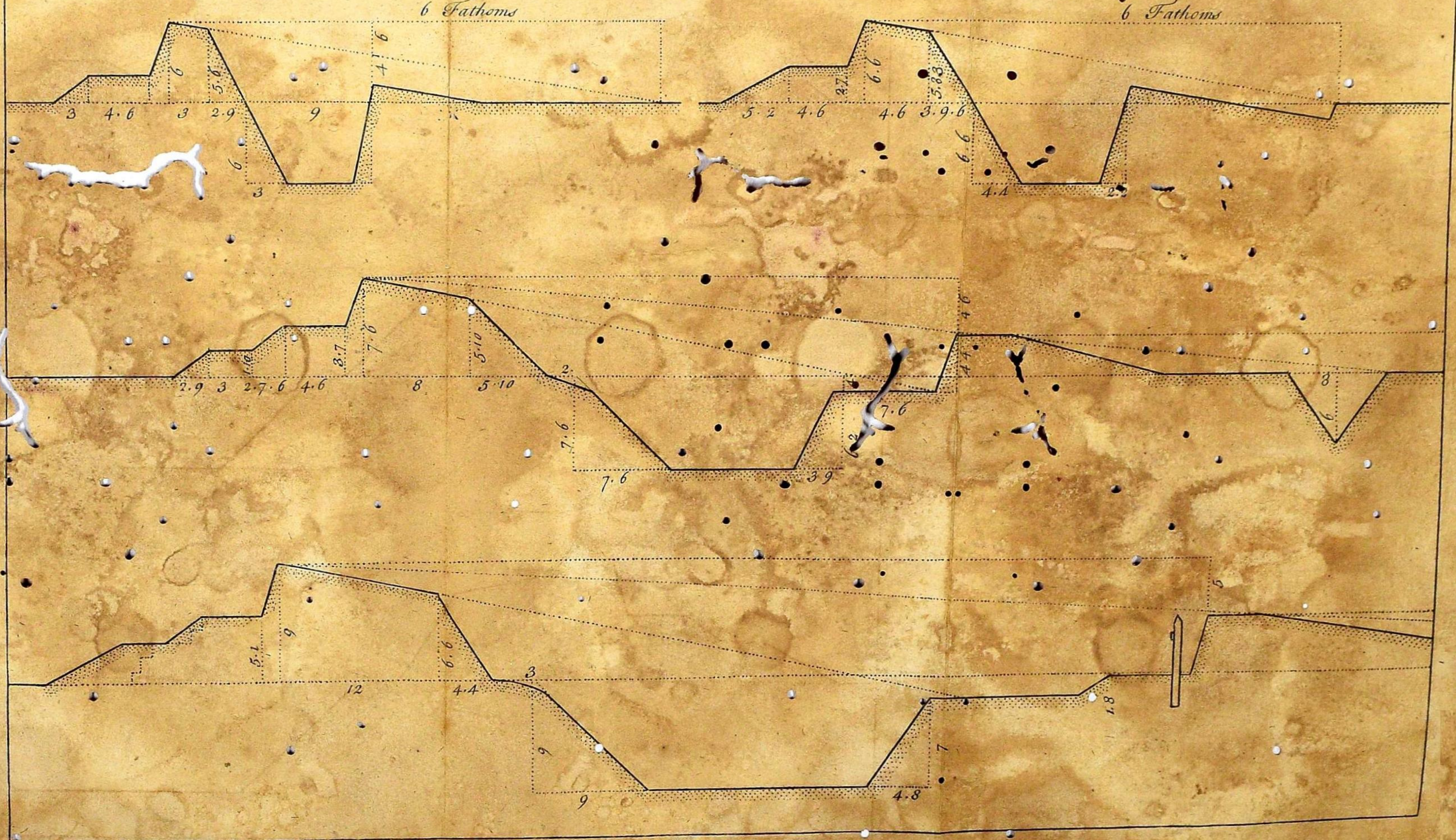
On the contrary, I think the depth should not be less, if possible, than 6 feet, which must be preferred to its breadth, otherwise the enemy may easily leap over, or too easily fill it up.

The distance of the advanced ditch from the counterscarp is regulated by the precautions mentioned in chap. 2. As we have seldom occasion for the earth taken from it, we make it small, and finish the little glacis beforementioned. I would have the slopes of this ditch, dry or wet, meet at the bottom; in the first case the enemy cannot stand there, and in the other, it will not be less difficult to pass: their depth must at least be 6 feet, and their breadth 7, that they may not be easily leaped over.

XI. Slopes depend on the consistence of the earth, but though we cannot determine any thing positive in this respect, it is proper to form a general rule to avoid errors.

The nearer the soldier is to the crown of the parapet, the better he can follow the direction of the slope or plunge; therefore the inside will be better to be quite perpendicular.

PROFILS



lar, but as this can ſeldom be done, we give it as little ſlope as poſſible, which is commonly about one third of the height. M. *Vauban* gives to thoſe of the ſcarp and counterſcarp one third of the breadth of the ditch; I do not ſee his reaſons for this, it is evident that the nearer theſe parts approach a perpendicular, the more difficult they are to aſcend and deſcend: it is therefore by the nature of the ground, and not the breadth of the ditch, that this muſt be regulated. In ſandy ground the ſcarp muſt conſequently be a foot in a foot ſlope; but with ſtrong and bold earth, two thirds, or even half may be ſufficient. We cannot give it leſs, becauſe this part ſupporting the whole parapet, may otherwiſe run the riſk of falling down, but as the counterſcarp is not in the ſame ſituation, we may ſcarp it as much as poſſible, eſpecially when the work is to ſubſiſt but a few days. I only ſpeak here of dry ditches; when they are wet, or full of water, theſe ſlopes muſt not be ſo ſteep to allow for the waſte made by the water.

We ſometimes find light and poor earth, which cannot be uſed without danger. In this caſe we muſt not only increaſe the ſlope, but alſo leave a berm of 2 or 3 feet between the ſlope and the foot of the parapet, which berm muſt be rounded, that the enemy may not halt there, and take breath.

XII. I have in many places in this chapter obſerved, that for want of giving all the

neceſſary plunge or ſlope to the parapet, the enemy are leſs expoſed to a direct fire, in proportion as they advance to the counterſcarp: ſo eſſential a defect, eſpecially in works without flanks, did not eſcape M. *Vauban*; he remedies this, by forming with the remainder of the earth a ſmall glacis, which cannot be mounted, without the enemy loſing this advanta[illegible]

As ſimple as [illegible]he c[illegible]ction of this work is, it requires ſome attention; if the glacis be too high, it ſerves the enemy as a cavalier of the trench, to fire plunging; if it is too low, it does not produce the deſired effect.

M. *Vauban* ſeems to have fixed this height at four feet and a half below th[illegible] crown of the parapet. We ſhould never [illegible]ive it more, eſpecially if we follow his pro[illegible]ls, ſince the ſummit of the glacis is thus o[illegible] a level with the banquet; with regard of giving it leſs, that muſt be regulated by the direction of the plunge, the only object being to diſcover the enemy entirely, or at leaſt lower than the waiſt, when he is on the edge of the ditch; I ſay below the waiſt, that is about two feet from the ground, becauſe they commonly ſink themſelves on theſe occaſions.

The ſame muſt be obſerved for the ſlope; that is it muſt be ſuch, that there be no part where a man is not ſeen entirely. In conſequence of theſe maxims, the glacis is perfect, when without being too high, it is in

a

a line with the plunge, or slope of the parapet.

This glacis has besides this, two other advantages, one in adding to the depth of the ditch, by raising the counterscarp, the other, in partly covering the work from the fire of artillery.

We sometimes make a covert way, to redouts, heads of bridges, and other works depending only on themselves, if their small elevation does not appear an insurmountable obstacle: in this case I would sink the counterscarp, to preserve the necessary command to the crown of the work. This loss seems more than compensated by this rasant, or grazing fire, which I draw from the covert way, and which cannot be obtained from the parapet, before the enemy are on the glacis.

The designs here referred to, will explain my thoughts; it will still be better if the crown of the glacis be level for some feet, as the fire following this direction in a flat, and even ground, will be the most advantageous in every respect.

OBSERVATIONS on the thirteenth chapter.

Tho' the plans of all the different works, are ever so well laid down, yet, if the profils are not well regulated, the works lose a great deal of their advantages; and as the ground is seldom on a level from one

one end of a retrenchment to the other, or before it, as far as cannon-ſhot, a profil that is very proper in one place is not ſo in another, where the ground changes its level. It is therefore the engineer's duty to examine very exactly what profil is neceſſary, in regard to the ſituation: I could give many examples, where the ſoldiers could be ſeen to their very ſhoes, at a ſmall diſtance from the parapet. The profil ought therefore to be altered not only on account of the ſituation of the line, but likewiſe on the ground before it.

When the proper height of a profil is determined, its thickneſs or ſtrength muſt be conſidered next; and where cannon can be brought againſt it, placed nearly on the ſame level, or higher than that of the line, no leſs thickneſs can be given to the parapet than 12 feet, and if time will permit it ſhould be from 15 to 18 feet, for no leſs can ſtop a cannon ball; but if the battery is lower than the level of the line, from 6 to 12 feet thick will do; ſince the ſhot will in this caſe fly upwards after it has hit the parapet. But in ſuch places, where the enemy cannot bring any cannon againſt, a thickneſs from 6 to 9 feet will do very well.

When a parapet is obliged to be made very high, ſeveral banquets or ſteps muſt be made for the ſoldiers to mount and fire; but as the fire from a high parapet diſcovers the ene-

my

my but at a diſtance, and cannot hurt him when near; there ought to be flanks made if poſſible to ſcower their ditches; and beſides, the ſlope of the parapet muſt be as great as is conſiſtent with ſafety. This defect may likewiſe be remedied in part, by flinging part of the earth taken out of the ditches, on its counterſcarp, in the form of a glacis, and leaving a banquet for the ſoldiers to ſtand upon, and to fire from thence, till the enemy comes cloſe, and retire afterwards thro' the barriers. Mr. *Vauban* made his ditches uſually larger than was neceſſary to have earth enough for the parapet, whoſe height he fixed at 7 feet 6 inches French meaſure, which makes about 8 feet of ours. In ſuch caſes, the remaining earth may be thrown on the counterſcarp, as we obſerved before, which will make the fire grazing from the parapet, all along this glacis. And when time will permit, a ſecond ditch with pits full of ſtakes, before the part of the intrenchment moſt eaſy of acceſs, will prove a very great obſtacle to the enemy in his approach.

As to the proper ſlope of the parapet, it intirely depends on the height of the profil, and the nature of the ground before it, but it ſhould always be, if poſſible, ſuch as to produce a grazing fire, which cannot be done when the parapet is high, without raiſing a glacis on the outſide, as before mentioned. As the author has been very attentive in explaining

plaining the ſeveral parts of profils, and how they are to be made according to the circumſtances that may happen, I ſhall conclude with recommending to the reader always to have the draught before him, when he reads any part referred to them.

FINIS.

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